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Program: EREE: Early Research Experience in E-Term
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Advisor(s): George D. Pins

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Program: CLIMB@WPI
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Author(s): Annabelle K. Feller, Stephen M. Larson
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Title: Effects of Tensile Strain on Ti3C2Tx Thin FIlms

Author(s): Mattan Mohel,
Program: STAR Fellowship: Summer Training in Arts & Sciences Research
Advisor(s): Jeannine Coburn, Kateryna Friedman, Lyubov Titova

2025 Summer Research Showcase - Abstracts

Poster #1

Biophilic Facades: Developing Green Panels by Decomposing PLA

Authors: Victoria Preble, Lauren Shieh

Summer Program: EREE: Early Research Experience in E-Term

Department: Civil Engineering, Architectural Engineering

Advisor(s): Soroush Farzin

Abstract:

In the United States, city temperatures can be up to 7°F warmer than rural temperatures. This common phenomenon is referred to as the Urban Heat Island Effect (UHI). Cities have significantly higher temperatures because natural vegetation is replaced with heat-absorbing materials such as pavements, buildings, and asphalt. These materials re-emit absorbed heat and cause heat islands, which contribute to global warming. Through sustainable building design, we can mitigate heat islands by increasing vegetation in urban areas. Biophilic facades allow live vegetation to grow on the exterior of buildings. Polylactic Acid (PLA) is a biodegradable thermoplastic used for manufacturing and 3D printing. This non-toxic material can be used to produce sustainable facades that encourage moss growth while simultaneously decomposing itself. The present study focuses on the decomposition of Polylactic Acid (PLA) and how it can be developed as a sustainable foundation to grow moss on biophilic facades.

Poster #2

Knockout of indiscriminate terminal-nucleotidyl transferase, GLDR-2, compromises male fertility in C. elegans

Authors: Shuling Lin, Brian Riley

Summer Program: EREE: Early Research Experience in E-Term

Department: Biology & Biotechnology

Advisor(s): Karl-Frédéric Vieux

Abstract:

GLDR-2 is a terminal nucleotidyl transferase in Caenorhabditis elegans that adds mono-A tails to microRNA precursors, and poly-A, poly-U, or mixed tails to other coding and non-coding RNAs. It is robustly expressed in the hermaphrodite germline, making it a gene of interest for reproductive biology. While prior research has shown that the absence of GLDR-2 does not affect hermaphrodite fertility, it may play a role in the fertility of male worms. Qualitative observations suggest that the absence of GLDR-2 in male nematodes may impact fertility due to difficulty in generating and maintaining a population of gldr-2 null males. To characterize GLDR-2 expression in male worms, GFP-tagged GLDR-2 male nematodes were generated using two methods. The first method involved crossing wild-type males with GFP-tagged hermaphrodites, while the second consisted of heat shocking GFP-tagged hermaphrodites to disrupt meiosis and generate the XO male genotype. GFP-tagged GLDR-2 males were imaged using confocal microscopy, revealing nuclear expression of GLDR-2 throughout the male germline. GLDR-2 expression decreases after pachytene and is absent during the later stages of meiosis and spermiogenesis. Additional imaging with DAPI or mCherry staining will be used to visualize germline nuclei to identify specifically which stages GLDR-2 is present in. The offspring produced by gldr-2 null males were quantified through 5-day brood counts. Crosses between gldr-2 null males and wild-type hermaphrodites resulted in fewer offspring when compared to brood counts from wild-type males and wild-type hermaphrodites. On average, the crosses with gldr-2 null males decrease about 33% in comparison to crosses with wild-type males. Future brood counts using feminized hermaphrodites that lack sperm will further validate GLDR-2's role in male fertility.

Poster #3

RevDecode for Ghidra: Context-Aware Function Matching in an Open Framework

Authors: Daniel Reynolds

Summer Program: STAR Fellowship: Summer Training in Arts & Sciences Research

Department: Computer Science / Cybersecurity

Advisor(s): Robert J Walls

Abstract:

Binary reverse engineering is a critical task in the field of security, which has many types of tools and approaches associated with it. RevDecode is one such tool which allows for function matching based on relevance, rather than purely similarity. In this work, we apply the approach of RevDecode and apply it to a Ghidra plugin, which allows for features and improvements beyond the initial RevDecode project.

RevDecode for Ghidra facilitates performance improvements compared to the original RevDecode due to the Ghidra API features the code has access to, in running as a Ghidra plugin. Furthermore, the plugin platform allows for the effective and continued performance testing of the algorithms and approaches used, not only in pure performance tests, but also in realistic reverse engineering environments, therefore allowing us to evaluate the limitations and scalability of our work.

Furthermore, RevDecode for Ghidra implements features that integrate into the reverse engineering

workflow, notably the ability for the user to view function matches based on the currently selected function in Ghidra's symbol tree. This allows the user to jump directly to the function's match by clicking on the function's name via the matcher window, which opens the binary containing the matched function, allowing the user to switch easily between the unknown and the matched function. Additionally, in supporting the plugin's use in a realistic reverse engineering environment, the plugin has the ability to match binary solutions to binaries in the corpus and view these solutions in the plugin, which benefits a realistic use case, a reverse engineering capture-the-flag challenge.

Poster #4

Flavylium-Coated Windows Fighting Energy Loss

Authors: Mishalena Raduazo

Summer Program: EREE: Early Research Experience in E-Term

Department: Chemical Engineering

Advisor(s): Anita Mattson

Abstract:

Energy loss from buildings accounts for approximately 30% of carbon emissions in the United States, largely driven by heating and cooling demands. Windows contribute to about 30% of this energy loss, making them a critical target for energy efficiency improvements. This research investigates an adaptive window coating composed of flavylium ions, which dynamically respond to changes in ultraviolet light intensity throughout the seasons. This study focuses primarily on resin and PDMS as carrier materials for the flavylium-based coating system. During summer, the coating darkens by absorbing UV light, thereby reducing solar heat gain and cooling loads. In winter, the coating becomes transparent, maximizing solar heat gain to decrease heating requirements. This coating technology offers a promising strategy to reduce building energy consumption, lower carbon emissions, and enhance occupant comfort year-round.

Poster #5

Reflection – On – Action: Observations on Lightweight Team Structure

Authors: Caleb Prouty

Summer Program: Mass Digi

Department: Interactive Media and Game Development

Advisor(s): Max Chen, Gillian Smith

Abstract:

Interactive art is a growing industry containing teams functioning in unique ways, with groups of small size operating under many constraints and open ended goals, leading to diverse team structures. MELT is a project being developed by Joe Square game company that aims to create an immersive, interactive art experience with a focus on collaborative puzzle solving. Aspects of the MELT team such as its small scale, remote work environment, and exploratory development style led to a novel team dynamic. This research took an auto-ethnographic approach where I observed team characteristics while working as an intern on a ten person team over the course of two months, attending team meetings, working one-on-one with team members, and completing tasks with creative freedom. This resulted in a definition for a team I call the "lightweight team", where the group is made up of talented individuals with a large amount of freedom and ownership over assigned work and reduced managerial overhead. Having this definition will enable other groups in creative and research industries to use a team structure that is flexible, requires little management, and reduces the need for upfront design.

Poster #6

Machine Learning Scripting for Literature Mining

Authors: Natalie Gaschits

Summer Program: REU: Functional Materials

Department: Chemical Engineering

Advisor(s): N. Aaron Deskins

Abstract:

Every day, thousands of material science papers are published in scientific literature databases. This makes it difficult for researchers to keep up with all of the new knowledge and studies that are available. Machine learning algorithms are skilled at analyzing and synthesizing information and can make literature searching much more efficient. We developed a Python script that uses natural language processing and statistical analysis to survey scientific literature related to the field of material science. XML and HTML parsing allow users to quickly read through query- and keyword-specific papers and determine which ones best fit their needs. Complex machine learning models were used to provide text processing for material science-specific vocabulary. Our code can be used to search databases such as PubMed and obtain key article information, as well as provide multiple filtering options to further narrow down user queries. This tool will let the user conduct a more efficient literature review and gain a deeper, more accurate understanding of the current state of relevant fields. This text mining script can be applied on a broader scale to obtain information from more databases, plot graphs and make figures related to results, find correlations between conclusions, and respond to further user queries.

Poster #7

Decomposition of Polypropylene Powder Under Hydrothermal Conditions

Authors: Korey Chen, Amelia Montgomery

Summer Program: EREE: Early Research Experience in E-Term

Department: Chemical Engineering

Advisor(s): Alex Maag, Michael Timko

Abstract:

Plastic has been largely integrated into everyday life from packaging and containers to everyday appliances and objects. Waste plastic can be recycled by breaking it down into smaller pieces which are melted and reformed, or chemically through depolymerization into its monomers which can be repurposed. Hydrothermal liquefaction (HTL) is a type of chemical recycling that has the potential to convert plastics into chemicals at high temperature and pressure conditions. A study conducted by Xu et al., [4] claimed to achieve a 64.1% conversion of polypropylene (PP) powder at 160 °C and low pressure conditions, with the addition of hydrogen peroxide (H2O2) as an oxidation-enhancer. A previous study done by Montgomery, Burati, Roy applied plastic pellets, a more realistic form of plastic waste, rather than powder. However, using pellets led to minimal conversion across all the trials at 160 °C, so powder was used instead to reproduce the data from Xu et al., 2025. Experiments were conducted with polypropylene powder, water, and hydrogen peroxide in a fluidized sand bath at a temperature of 160 °C, and for a reaction time of 2 hours. Though the experimental conversion values were higher compared to Montgomery, Burati, and Roy, it was still significantly lower than those reported in Xu et al., 2025. The highest conversion value found was 35% at a dosage of 4% H2O2. The inclusion of H2O2 increased depolymerization in the PP powder with higher dosages increasing overall conversion. On the contrary, Xu et al., 2025 found their highest conversion at 1% dosage of H2O2 with higher doses leading to decreased conversions with a small increase at 4%. The results of this study were found to be incomparable to that of Xu et al., 2025, but further instrumental analysis will be done on the samples to identify any chemicals present.

Poster #8

Sustainable Conversion of Shale Gas Waste into a Bio-Crude Oil

Authors: Tanner Smith

Summer Program: EREE: Early Research Experience in E-Term

Department: Chemical Engineering

Advisor(s): Alex Maag, Mike Timko

Abstract:

In 2023, 323.5 billion cubic feet of shale gas was vented/flared, which led to 4.7 billion dollars worth of methane to be wasted. This is also a significant contributor to greenhouse gases. The startup company, M2X energy, has developed a method to convert the wasted methane into a dirty methanol. Because the product is not pure, there is not much of a market for the methanol they produce, and purification is costly and energy intensive. Our objective was to add the dirty methanol into our hydrothermal liquefaction (HTL) process to convert bio-waste into an energy dense bio-crude oil. The aspect of this process that we focused on for the summer was the percentage of methanol in water loaded into the reactor in order to optimize the yields of oil. Results showed that the methanol loading had a dramatic effect on the oil yields, with 25% methanol in water was the best performing for each feedstock. These results allow us to make an economically viable process using the dirty methanol, giving M2X a reason to continue to convert wasted methane into methanol, and stopping the release of hundreds of billions of cubic feet of natural gas into the atmosphere.

Poster #9

Non-Destructive Testing Methods for Applications in Metal 3D Printing

Authors: Ryan Ng and Jonathan Amirault, Jonathan B. Amirault, Dr. Danielle L. Cote, Ryan T. Ng, Dr. Kyle L. Tsaknopoulos

Summer Program: Cote Research Lab

Department: Mechanical and Materials Engineering

Advisor(s): Dr. Danielle L. Cote, Dr. Kyle L. Tsaknopoulos

Abstract:

Cold Spray Technology is a solid-state metal additive manufacturing process that has found use in military and commercial applications. Current research in this field focuses on optimizing the parameters of the process to maximize mechanical properties. To quantify a sample's properties, traditional destructive testing methods are commonplace. However, these methods are not always applicable, especially in real-world situations. In this study, we analyzed the viability of two non-destructive testing methods for use with cold spray technology. This study focused on ultrasonic testing and eddy current testing to understand future use-case scenarios for the technologies. Through this study, it was determined that ultrasonic testing excels at visualizing large internal defects. On the other hand, eddy current testing found use in characterizing samples and detecting defects. Working closely with these two non-destructive testing methods helped fellow researchers become familiar with the technologies, which will allow for future applications in the field of cold spray technology.

Poster #10

Determinants of Financial Well-Being

Authors: Keyla Padilla

Summer Program: EREE: Early Research Experience in E-Term

Department: Business School, Management Engineering Major

Advisor(s): Farnoush Reshadi

Abstract:

Financial well-being (FWB) — "the perception of being able to sustain current and anticipated desired living standards and financial freedom" (Brüggen et al., 2017, p.229) — is an important aspect of overall well-being and life satisfaction. Experiencing low financial well-being can significantly affect individuals' mental and physical health, limit their access to necessary services, and strain relationships at home and at work (Netemeyer et al., 2018). Therefore, it is important to understand what factors lead to having higher financial well-being for consumers. This paper aims to explore the key factors that influence individual financial well-being.

Using data from the 2021 National Financial Capability Study (NFCS), a large national dataset collected by the Financial Industry Regulatory Authority (FINRA) corporation, we analyzed survey responses to assess the influence of 11 variables including consumer financial behavior and perceptions (risk taking, frugality, financial confidence, credit card behavior, engagement with healthcare), financial literacy (objective and subjective), and demographics (income, education, age, gender) on consumers' FWB.

After cleaning the data, we ran multiple linear regression analyses using Python (version 3.12.3) to test our proposed hypotheses.

Our findings showed that financial confidence, positive credit card behavior, frugality, and engagement with healthcare among other variables had the strongest effect on financial well-being.

These findings suggest that beyond demographic factors, an individual's financial behaviors and perceptions play a crucial role in shaping their financial well-being. These insights can inform programs and policies designed to strengthen individuals' financial stability, and well-being.

Poster #11

Effect of Staphylococcus epidermidis Growth on the Mechanical Properties of the Growth Environment

Authors: Cassidy Griffith, Sydney R. Packard

Summer Program: REU: Integrated Bioengineering Research

Department: Biomedical Engineering

Advisor(s): Ph.D., Elizabeth J. Stewart

Abstract:

Staphylococcus epidermidis is a leading cause of bloodstream infections linked to biofilm formation on implanted medical devices. Bacterial biofilms are structured bacterial communities embedded in self-produced extracellular polymeric substances. The goal for this project is to understand how S. epidermidis biofilms affect the mechanical properties of their surrounding environments. Specifically, we will grow bacteria in sodium alginate hydrogels with varying concentrations (0.35% and 2.2%) to represent different tissue microenvironments. Bulk mechanics of bacteria-hydrogel composites are compared to the mechanics of unconfined bacterial biofilms and sodium alginate hydrogels without bacteria. Bacteria-hydrogel composite mechanics are evaluated before and after bacterial growth for 24 hours. The storage modulus (G') was ~800 Pa for 0.35% alginate hydrogels and bacteria-hydrogel composites, and ~10,000 Pa for 2.2% alginate and bacteria-alginate composites. Interestingly, there was no significant difference between alginate hydrogels without bacteria and the bacteria-hydrogel composites regardless of concentration. The storage modulus of S. epidermidis biofilms was 1,500 Pa, and similar to that of the 0.35% alginate hydrogels. Yield stress (□yield) values for alginate hydrogels and bacteria-alginate composites prior to bacteria growth (t=0 hours) were comparable; however, after 24h of growth, yield stress increased 4.5x in 0.35% bacteria-alginate composites and 3x in 2.2% bacteria-alginate composites. Thus, bacterial growth within hydrogels results in materials that are more resistant to deformation than those without bacteria. Yield stress of 2.2% alginate hydrogels was 11.5x higher than that of 0.35% hydrogels; however, the increase in yield stress for the bacteria-hydrogel composites occurred in both formulations. The yield stress of the biofilms was more similar to that of the 2.2% alginate hydrogel. Confocal microscopy demonstrated that bacterial microstructure varied significantly between confined and unconfined microenvironments. Evaluating biofilm growth in varying mechanical environments will advance the understanding of site-specific biofilm formation and enable development of site-specific therapeutic strategies.

Poster #12

Investigating The Roles of KhpA & KhpB in Stress Tolerance in M. Smegmatis

Authors: Victoria Turner, Victoria

Summer Program: LaPre Fellowship

Department: Biology & Biotechnology

Advisor(s): Professor Scarlet Shell

Abstract:

Understanding bacterial stress adaptation is critical in addressing persistent infections like tuberculosis. RNA-binding proteins (RBPs) help bacteria survive stressful environments by controlling how genes are turned on or off (1). In Mycobacterium species RBPs are especially important during stress from things like low nutrients, antibiotics, or oxidative damage, helping the bacteria adapt by supporting stress-related gene expression (1). RNA-binding proteins such as KhpA and KhpB are regulators of post-transcriptional gene expression, but their functions in mycobacteria remain poorly defined. This project aims to idenifity how KhpA and KhpB contribute to stress tolerance and gene expression in Mycobacterium smegmatis, a nonpathogenic model for M. tuberculosis.

We hypothesize that KhpA and KhpB regulate RNA stability and gene expression under stress. Prior work in the Shell lab shows that khpA deletion impairs growth, and Co-IP data suggest both proteins interact with RNase E and with each other (2,3). Together, KhpA and KhpB may influence RNA turnover or compete with ribosomes for regulatory control.

To test this, I am assessing stress tolerance in wild-type, khpA and khpB knockout, and complemented strains of M. Smegmatis under oxidative, nitrosative, and nutrient stress. These findings will clarify mechanisms of RNA regulation in mycobacteria and may highlight new targets for improving tuberculosis treatment.

Poster #13

From Chaos to Clarity: Strengthening 3D Collaborative Autonomous Vehicle Perception with Noise-Aware Training

Authors: Allie Lopez, Jose Morales, Everett Richards

Summer Program: REU: Applied Artificial Intelligence for Advanced Applications

Department: Data Science

Advisor(s): Ziming Zhang

Abstract:

Deep learning has revolutionized perception in autonomous vehicles (AVs), particularly in collaborative systems that fuse data across multiple agents. However, most collaborative object detection frameworks assume high-fidelity sensor input and degrade sharply when exposed to noise, occlusion, or sensor failure—conditions common in real-world deployment. In this work, we present a noise-aware training framework that injects Gaussian noise into LiDAR point clouds during training to improve robustness. Using the BM2CP collaborative perception architecture and the DAIR-V2X dataset, we evaluate four training regiments with progressively increasing noise levels across 800 inference trials. Results show that models trained with noise degrade more gracefully under inference-time noise and converge faster than baseline models. A model trained with heavy noise for just 20 epochs outperforms a baseline trained for 50 epochs when evaluated on degraded input, highlighting both robustness and training efficiency. These findings demonstrate that

robustness to sensor noise can be learned and scaled through curriculum-like exposure, offering a path toward more generalizable and resilient AI perception systems.

Poster #14

Employing Operator Learning for Real-Time Hemodynamic Prediction: Synthetic Data Study

Authors: Guangjing(Grace) Cao

Summer Program: STAR Fellowship: Summer Training in Arts & Sciences Research

Department: Mathematical Sciences and Data Science

Advisor(s): Alan Wei, Zhongqiang Zhang

Abstract:

This project develops a deep learning-based surrogate model that combines operator learning, with reduced-order modeling for efficient and accurate prediction of blood flow dynamics. Since the classical DeepONets take a longer time to train, we apply model reduction methods to reduce the dimensionality of the input and output. Next, we redesign and train the two components of DeepONets based on the reduced dimensional input and output. Finally, the DeepONets are refined by minimizing reconstruction errors over the full spatiotemporal domain. The surrogate operator thus learns to capture high-frequency dynamics beyond classical reduced-order models, while maintaining computational efficiency. The efficiency of this methodology is demonstrated with several examples. The next step is to validate the trained neural operator using real-world clinical data.

Poster #15

Magnetic Imaging of Current Flow in Ink Containing Silver Nanoparticle Using Nitrogen-Vacancy Centers in Diamond

Authors: Jacob Feinstein, Natalie Frey, Lauren Lachapelle, Milica Miladinovic, Jacob Myers, Pratap Rao, Raisa Trubko, Zach Zastawny

Summer Program: REU: Functional Materials

Department: Physics

Advisor(s): Raisa Trubko

Abstract:

Inkjet printing of silver nanoparticle inks is used to fabricate thin flexible electronics and sensors. Printing parameters such as drop spacing greatly influence the shape of printed silver conductive traces, including the width, thickness, and shape of the edges and the cross-sections. For instance, printing at moderate drop spacing results in wider traces with straight edges, while printing with larger drop spacings resulting in narrower traces with scalloped edges. Our objective was to experimentally characterize electrical current flows through printed silver traces fabricated with different drop spacings. However, imaging the electrical current flow through the conductive traces with high spatial resolution is a challenge. Here, we use wide-field vector magnetometry with Nitrogen-vacancy (NV) centers in diamond to image magnetic fields produced by electrical current flow through inkjet-printed traces. We demonstrate millimeter-scale field of view with micron-scale spatial resolution. From the vector magnetic imaging data, we reconstruct the current density using inverse spectral analysis techniques. Additionally, optical imaging and stylus profilometry were used to define the shape of the inkjet-printed silver traces. Four-point probe measurements were taken to measure total resistance, conductivity, and current, for comparison to NV diamond magnetic imaging. This work demonstrates spatially resolved measurements of current flow within inkjet-printed silver traces using NV diamond magnetic imaging.

Poster #16

Log Anomaly Analytics Platform (LAAP): Structure, Pinpoint, Explain, Explore

Authors: Suhani Chaudhary, Ethan Shanbaum, Athanasios Tassiadamis

Summer Program: REU: Applied Artificial Intelligence for Advanced Applications

Department: Data Science

Advisor(s): Lei Ma, Elke Rundensteiner, Peter VanNostrand

Abstract:

Log anomaly detection is vital for identifying critical system failures like data breaches, which cost organizations millions each year. However, dense and fragmented system structures make root cause analysis difficult and time-consuming. To address this, we present the Log Anomaly Analytics Platform (LAAP), an interactive system that uses large language models (LLMs) to structure log data, detect anomalies, and provide clear, contextual explanations. LAAP extracts hierarchical templates from flat logs by identifying entities, actions, and statuses. It detects two key types of anomalies. Template anomalies occur when an individual log message deviates from the expected structure, while sequence anomalies arise when a series of log messages differs from known normal patterns in the knowledge base. When an anomaly is identified, LAAP highlights the divergence from normal patterns and presents an LLM-generated explanation, helping users understand what went wrong and why. The platform also supports similarity search, manipulation tracking, and predictive insights, enabling deeper exploration of system behavior. In a user study with five participants and seven task scenarios, LAAP achieved a 97% task success rate and an average completion time of just over five minutes, demonstrating both usability and effectiveness. These results highlight LAAP's potential as a powerful, LLM-driven tool for simplifying log analysis and accelerating root cause diagnosis in complex systems.

Poster #17

An Experimental Technique for Measuring Flow Rate in Microchannels

Authors: Remy Kaplinsky

Summer Program: EREE: Early Research Experience in E-Term

Department: Applied Physics & Mechanical Engineering

Advisor(s): Francesca Bernardi

Abstract:

Mathematical modeling of wave and flow rate propagation through quantum graph networks serves applications in many fields such as water waves and electrical circuits. However, no simple, accessible experimental methods currently exist for verification of model predictions. While enclosed microchannels cannot be used to run wave experiments, the microfluidic scale offers desirable characteristics for verification of flow rate propagation due to the relatively controlled experimental conditions, laminar flow, and ease of manufacture on inexpensive consumer craft cutters. Taking advantage of these properties, we developed a relatively simple method to measure the flow rate in straight microchannels: we inject a channel-spanning bubble into a microchannel, take a video to capture its progression, and use MATLAB to track it through the channel as it moves, driven by a constant volumetric flow rate imposed by a programmable syringe pump. Dots with known spacing printed on a standard 2D laser printer are placed under the transparent microchannel to allow for precise scaling of pixels to millimeters. This method can estimate the flow rate of the fluid to within 5% of the known setting of the pump at various channel widths and flow rates. Future work includes extending this method to measure the flow rate in branching channels to understand its dependence on branching angle and branches' width. Such experiments could be used to benchmark and guide mathematical models of propagation of flow rates through quantum graphs.

Poster #18

Preliminary Research for the Visual Novel Lab

Authors: Charles Dugaw

Summer Program: STAR Fellowship: Summer Training in Arts & Sciences Research

Department: Interactive Media and Game Development

Advisor(s): Karen Stewart

Abstract:

Next semester, the Interactive Media and Game Development program is establishing a research lab to study visual novels (VNs), a genre of video game characterized by a focus on text-based storytelling. The goal of my research this summer was to explore methods for studying these games. After performing a review of existing literature on the topic, I selected and played 6 VNs and developed story mapping as a procedure for analyzing them. Story mapping, which visualizes the branching structure of a VN's narrative, has proven to be a powerful and versatile tool for analyzing, comparing, and generating insights about these games. As the technique is reproducible across different games and different researchers, it will be incorporated into our lab's research approach, which we will continue to iterate upon and expand as the lab does research.

Poster #19

Injector Design for Drug Delivery in MRI Environments

Authors: Maya, Yang Wang

Summer Program: WPI BME REU program

Department: Mechanical Engineering

Advisor(s): Gregory S. Fischer

Abstract:

Magnetic resonance imaging (MRI)-compatible neurosurgical robots offer a stereotactic method to identify target locations in the brain in real-time, significantly reducing dangerous uncertainties of more traditional methods involving preoperative imaging. Drug delivery in these applications require precise flow rates, yet existing syringe pumps that achieve slow and controlled drug delivery contain high amounts of materials incompatible with MRI environments. This ongoing work proposes the design of an entirely non-ferrous, low-metal injection device aimed at delivering drug agents within the AiM Medical Robotics neurosurgical robot. The injector is composed of a low-pitch, piezoelectric motor-actuated lead screw and a pushing block that linearly translates a syringe plunger into its corresponding barrel. A Python-based simulation utilizing the Hagen-Poiseuille equation was developed to estimate the ideal inner dimension of medical tubing outputting therapeutic drugs from the syringe head without exceeding a safe pressure threshold for intracerebral infusion. Preliminary analysis yielded promising results, with an injection dosage error of 7% for a 30 RPM motor speed and 2% for 20 RPM, 10 RPM, and 3 RPM motor speeds. Future work involves adapting the system to different flow rates for different drug delivery applications such as gene or cell therapy. This work aims to enable a precise method of drug delivery without compromising real-time brain navigation.

Poster #20

Analysis of post-processing methods for transparent 3-D printed anatomical phantoms for use in mock flow loops

Authors: Vijay Kesavan, Pritom Saha

Summer Program: REU: Integrated Bioengineering Research

Department: Biomedical Engineering

Advisor(s): Zhenglun "Alan" Wei

Abstract:

The mock circulatory loop (MCL) is an important tool for the study of cardiovascular physiology, allowing for targeted in vitro study of specific portions of the cardiovascular system. Patient-specific MCLs are most commonly made with stereolithography 3-D printing (SLA printing). However, SLA printed models have low clarity, which makes optical analysis challenging. As optical methods are used extensively to study flow hemodynamics, this is a major impediment to in vitro study of cardiovascular disease. This study aims to compare the efficacy of various methods of post-processing used to prepare 3-D-printed MCL components for optical analysis. Simplified SLA printed models were post-processed with a number of methods and their optical properties compared.

The simplified model was a 5/8 x 2 1/2 in. (15.875 x 63.5 mm) rigid tube with a 1/4 in. (6.35 mm) thickness. Four simplified models were SLA printed with Form Clear V5 resin. Parts were printed at a 45° angle with a layer height of 0.050 mm. Parts were then washed, post-processed, and cured according to the material standard. An ideal simplified model was also made from acrylic tubing. Along with an unprocessed control, each SLA printed model was post-processed with a different method—either sanding, dip-coating, or spray-coating. Printed and post-processed models were imaged with an optical microscope and studied with PIV, a commonly-used method of optical analysis of fluid flow.

The sanded model had higher clarity and smoother surfaces than the untreated model. The coated models had higher clarity at the cost of greater distortion. While the ideal model was clearer than all of the SLA printed models, the clearest of the SLA printed models was the sanded model, and this treatment will be used on future SLA printed MCL components where possible.

Poster #21

PMKS+

Authors: David Peterson

Summer Program: EREE: Early Research Experience in E-Term

Department: Mechanical Engineering (I am part of the Computer Science department, the project is part of the ME department)

Advisor(s): Pradeep Radhakrishnan

Abstract:

PMKS+ is a web-based simulation tool used for kinematic analysis of mechanical linkages. The program is a refactor that needed updates to preserve legacy functionality. The program lacked an implementation for forces, notifications, and had an incomplete undo/redo feature that hindered iterative design. The primary contribution during EREE (Early Research Experience in E-Term) has been the addition of force vectors allowing users to add, modify, and visualize force vectors directly on linkage components. These forces remain coupled to their respective links during animation. The program now has a notification system that gives useful information to users. The undo/redo system was extended to cover nearly all user actions. PMKS+ now provides a more beginner-friendly user experience.

Poster #22

Development & Evaluation of PDMS Well Molds in 3D Fibrin Environments

Authors: Juanyong Li, Temya Jackson Long, Delaney Mohl, Rozanne Mungai

Summer Program: REU: Integrated Bioengineering Research

Department: Biomedical Engineering

Advisor(s): Kristen Billiar

Abstract:

Background: Cellular invasion is crucial for developing tissue-engineered heart valves. Dynamic stretch may have an influence. PDMS-made wells are stretchable and allow for studies on cell invasion. However, due to the nature of PDMS, bubble development poses an issue to durability of the PDMS mold.

Hypothesis: Dynamic mechanical stretch can influence cellular infiltration.

Goal: Evaluate and improve custom PDMS molds for cyclic stretch testing and 3D spheroid culture.

Methods:
PDMS well strips were fabricated by mixing 45:3 Sylgard 184 to crosslinker. To minimize bubbles, the mixture was degassed twice at -30 inHg before and after pouring into mold layers. A new step added to improve bubble elimination, the layers were sandwiched together then degassed twice again at -15 inHg for 10 min to allow bubbles to rise without overflow. Molds were cured at 46□C for 12 or more hours. Created multicellular spheroids using agarose gel molds, harvest the spheroids, embed spheroids into fibrin gel in PDMS wells, observe cell invasion in static and dynamic environments from day zero to day two.

Results: PDMS wells containing spheroids in static and dynamic environments were effective in supporting 3D cell culture formation, with 100% of seeded spheroids remaining intact over 72 hours. Their molded posts were able to hold the extracellular matrix consistently and avoided leakage, despite the small depth of the wells.

Conclusions: PDMS molds that withstand 10% cyclic stretch can be successfully created with the optimized bubble elimination method. They support clear staining, fixing, and imaging of spheroid multicellular migration over time.

Future work: Test durability of PDMS wells, validate method of well creation without bubbles, and increase depth of wells for greater media volume.

References & Acknowledgements:
1. Monteiro+ J. Plastination 2018
2. Li + [Master's thesis, University of Delaware] 2016
3. Mungai+ Sci Rep 2024
NSF REU Grant EEC2150076

Poster #23

Characterization of Distal Middle Cerebral Artery Territory in Stroke/Aneurysm Patients

Authors: Avedis Dola, Dr. Anna Kuhn of the Radiology Department and the image processing and analysis core (iPAC) at UMass Chan Medical School

Summer Program: EREE: Early Research Experience in E-Term

Department: Biomedical Engineering

Advisor(s): Professor Mohammed Salman Shazeeb

Abstract:

The characterization of the vessel anatomy of the distal middle cerebral artery (MCA) of stroke/aneurysm patients is important for the design of neurointerventional devices in treating these patients. The vasculature anatomy varies between patients as some may exhibit more complex anatomies, which makes it more difficult to characterize their MCA levels (M1, M2, M3, and M4). Typically, the computed tomography angiography (CTA) or X-ray scans of these patients are used to visualize vessels up to the M1 level (starting from the aortic arch to cervical (arch-cervical), cervical, petrous, and cavernous and T-junction (cavernous-T) levels), and there can be difficulty in visualizing vessels if the treatment site occurs up to the M4 level. To tackle this issue, we used imaging software, AMIRA, to segment the distal MCA vasculature from the M1 to the M4 level from stroke/aneurysm patients. We measured the tortuosity of the vessels to characterize this distal MCA region that can be helpful in the design of catheters/wires that would be navigated to this delicate

vasculature. For 3 fully segmented cases from the aortic arch to M1, an average centroid path tortuosity of 1.8±0.2 was measured for both the right and left sides. Another 20 cases were segmented for only the M1 to M4 regions, resulting in a right-side tortuosity of 4.8±1.4 and a left-side tortuosity of 4.5±1.7. Clearly, the M1-M4 vasculature displayed more tortuous vessels than the fully segmented arch to MCA cases warranting the design of different neurointerventional devices to navigate the distal MCA vasculature. Future deep learning/machine learning processes can be implemented to enhance analysis of cases in real-time that can aid neurointerventional radiologists in treating patients for better clinical outcomes.

Poster #24

Fabrication of Micropatterned Fibrin Films for Myoblast Alignment

Authors: Bridgette Bowyer, Bryanna L. Samolyk, Bianca Trope

Summer Program: none

Department: Biomedical Engineering

Advisor(s): Ph.D., George D. Pins

Abstract:

Volumetric muscle loss (VML) is the traumatic or surgical loss of skeletal muscle tissue, greater than 20% of the muscle volume, resulting in functional deficits and cosmetic deformity [1, 2]. By using micropatterned films made of fibrin, a protein that plays a major role in wound healing, environmental cues direct skeletal muscle cell growth by aligning myotubes to generate myofibers [7, 6]. Fibrin films were fabricated by mixing thrombin, combined with CaCl2, and fibrinogen then pipetting the mixture onto a micropattern, and allowed to polymerize. Each film contained two aligned patterns with varying dimensions (channel width x plateau width). The following measurements were tested: 8x8um, 10x10um, 15x15um, 50x50um, and 100x100um. Cell culturing was done on each micropattern on the films, adding approximately 20,000 cells to the top and bottom pattern on each film. Due to having high confluency, alignment on the micropatterned films could only be determined on one film. The alignment of 50 cells on Micropattern D (100x100um) was determined using ImageJ. Measurements of 15% or less were considered aligned, meaning 16 cells of the analyzed cells were aligned (32% total alignment). Films should undergo cell culture once more, decreasing the seed amount to avoid over confluency. The films differentiation behavior should also be observed to determine if the micropatterns on the films are able to influence the formation of myotubes. A comparison of the feature dimensions on the PDMS and fibrin films also indicates that the equal dimensions may refer to the height and width of each plateau, which should be confirmed through measuring PDMS and micropattern plateau heights. Despite the alignment percentage not being determined for all the films, micropatterned films should continue to be tested as they have the potential to play a key role in treatment of VML through allowing myoblasts alignment to generate myotubes.

Poster #25

Investigating the genomic contents of phage defense systems in Mycobacterium Abscessus

Authors: Akansha Pathak

Summer Program: MQP

Department: Department of Biology and Biotechnology

Advisor(s): Scarlet Shell, Junpei Xiao

Abstract:

Mycobacterium abscessus is a Nontuberculous Mycobacteria (NTM) that affects patients with chronic lung conditions and is usually treated with a multidrug regimen of antibiotics. Bacteriophage therapy is being explored as an alternative to treat M. abscessus, but the distribution of different phage defense systems poses a major difficulty in finding common lytic phages for treatment. The goal of the project is to explore the distribution of phage defense systems across multiple M. abscessus strains in order to find common phage defense systems that prevent specific phages from being active. For 79 M. abscessus strains, phage defense data was gathered using DefenseFinder. A dendrogram with a circular presence/ absence matrix was constructed from that data. It was found that the most common types of defense systems were Abortive Infective systems, CBASS, and Restriction Modification systems. The dendrograms showed that defense systems that were commonly found were vertically transferred while phage defense systems that were variable across genomes were horizontally transferred. It was concluded that most phage defense systems were variably distributed across M. abscessus genomes, and the common defense systems found were AbiAlpha (Abortive Infective), CBASS(Cyclic Oligonucleotide Based Signaling) and Dnd (DNA degradation).

Poster #26

Bench Testing of Luminescent Films for Calibration of Wearable Transcutaneous Oxygen Monitor

Authors: Gokalp Cevik, Gwyneth Rose-Smith

Summer Program: REU: Integrated Bioengineering Research

Department: Electrical and Computer Engineering

Advisor(s): Ulkuhan Guler

Abstract:

While non-invasive respiratory support systems are now widely in use within neonatal intensive care units (NICUs), monitoring the actual oxygenation achieved through these methods in a similarly non-invasive manner faces both size and efficacy challenges within this patient population, resulting in limited data on lung-function during care. Luminescent-film-based transcutaneous O2 monitoring equipment using miniaturized LEDs and photodetectors can meet this need, but it is first necessary to understand the effect of environmental variables such as temperature on readings from the film, and data is needed to correct for the associated variances. Using a gas bench and glass chamber, we collected 272 sets of 200 automated sensor measurements (each consisting of 10 averaged LED pulses) to test film response to ambient variation. Lifetime and temperature data were collected for each group of pulses, and changes to O2 percentages were alternated between increasing and decreasing steps to maximize variation. A temperature range of 6.8 °C was observed, with values from 21.9 °C to 28.7 °C recorded, though the majority of sampling took place within the two-degree range of 22 °C to 24 °C. This data will allow for the effective training of a machine learning model to effectively predict the partial pressure of oxygen from the measured luminescence-lifetime across various temperatures and to create a calibration stage for new sensor films to eliminate differences caused by part-to-part variation.

Poster #27

Strategy-Guided Learning in LLMs

Authors: Luca Dang, Co-Author: Elene Kajaia

Summer Program: STAR Fellowship: Summer Training in Arts & Sciences Research

Department: Computer Science

Advisor(s): Jacob Whitehill

Abstract:

Large language models (LLMs) are typically fine-tuned to solve tasks directly, but recent work has explored learning during inference. Parashar et al. (2025), for instance, proposed inference-time techniques to improve performance, though they found scalability limitations.
We take a different approach: instead of training models to solve problems, we train them to generate strategies for how to approach them. Our goal is to see whether strategy generation alone can match the performance of direct problem solving.
We test this idea on a challenging addition task involving three 12–13 digit numbers. In our pipeline, a model first tries to solve a problem. Then, a strategy model sees the example and generates a general approach, which is used to solve a new problem. This enables indirect learning through exposure to different strategies.
We evaluate three pipelines: (1) a model trained to both generate strategies and solve problems, (2) the same model with problem solving masked out so only the strategy head is trained and used, and (3) separate

models for strategy and solving, where only the strategy model is trained. All achieve ~80% accuracy, matching a baseline addition problem solver model trained directly on the task.
To ensure the strategy model was not implicitly learning to solve the problem, we trained it separately and used a different model at inference time. Performance remained the same, confirming that the strategy alone guided the solution.
These results suggest strategy generation is a viable alternative to task-specific training. Strategy models can produce prompts that guide solvers and even adapt during test time

Poster #28

Strategy-Guided Learning in LLMs

Authors: Luca Dang, Elene Kajaia

Summer Program: STAR Fellowship: Summer Training in Arts & Sciences Research

Department: Computer Science

Advisor(s): Jacob Whitehill

Abstract:

Large language models (LLMs) are typically fine-tuned to solve tasks directly, but recent work has explored learning during inference. Parashar et al. (2025), for instance, proposed inference-time techniques to improve performance, though they found scalability limitations.
We take a different approach: instead of training models to solve problems, we train them to generate strategies for how to approach them. Our goal is to see whether strategy generation alone can match the performance of direct problem solving.
We test this idea on a challenging addition task involving three 12–13 digit numbers. In our pipeline, a model first tries to solve a problem. Then, a strategy model sees the example and generates a general approach, which is used to solve a new problem. This enables indirect learning through exposure to different strategies.
We evaluate three pipelines: (1) a model trained to both generate strategies and solve problems, (2) the same model with problem solving masked out so only the strategy head is trained and used, and (3) separate models for strategy and solving, where only the strategy model is trained. All achieve ~80% accuracy, matching a baseline addition problem solver model trained directly on the task.
To ensure the strategy model was not implicitly learning to solve the problem, we trained it separately and used a different model at inference time. Performance remained the same, confirming that the strategy alone guided the solution.
These results suggest strategy generation is a viable alternative to task-specific training. Strategy models can produce prompts that guide solvers and even adapt during test time

Poster #29

Drying Moist Porous Media with Infrared Laser Technology

Authors: Itamar Harris, Owen MacNeill, Sydney Shilts

Summer Program: NSF REU

Department: Mechanical and Materials Engineering

Advisor(s): Dr. Jamal Yagoobi

Abstract:

Industrial-scale drying accounts for 1.2% of the total U.S. energy consumption (U.S Department of Energy Quadrennial Technology Review 2015), and is a major manufacturing challenge in energy-intensive industry sectors such as food, pulp and paper, and chemicals. In this project, laser technology in the near-infrared spectrum was explored as a way to increase the energy-efficiency of the drying process. Cranberries were selected as a test sample due to their high moisture content (88% wet-basis moisture content) and ability to withstand temperatures over 100°C. During testing, sample temperature was controlled automatically and the drying curve was measured in real time by a scale underneath the sample. After 15 minutes, the laser reduced the moisture content of the sample to 54%, with a peak drying rate above 9g/m2s. This is a promising result, and shows the potential for laser technology to quickly and efficiently remove large amounts of water from food products. Future work should improve the experimental setup for cranberries to improve the accuracy of efficiency calculations as well as exploring the suitability of laser technology for other products.

Poster #30

Effect of Inkjet Printing Parameters on Electrical Traces

Authors: Lauren Lachapelle, Milica Miladinovic, Zach Zastawny

Summer Program: REU Functional Materials

Department: Mechanical Engineering

Advisor(s): Pratap Rao

Abstract:

Inkjet printing of silver nanoparticle inks is used to fabricate thin flexible electronics and sensors. The advantage of this approach is in digital prototyping, mechanical flexibility, and compact design. We showed that drop spacing and substrate temperature can be used to vary the width and cross-sectional shape of the printed silver conductive traces. We experimentally characterized the traces using optical imaging, stylus profilometry, and electrical resistance measurements. We found that increasing substrate temperature

decreases the trace width and increases the coffee ring effect (thicker edges), while increasing the drop spacing decreases the trace width and increases the scalloping of the traces.

Poster #31

The Modification of Footwear for Marker-Based Motion Capture

Authors: Shruthi Mohanraja, Emma Slavin

Summer Program: EREE: Early Research Experience in E-Term

Department: Biomedical Engineering

Advisor(s): Karen L. Troy

Abstract:

Bone stress injuries (BSIs) are common overuse injuries among runners, often affecting metatarsals—the long bones of the foot. BSIs occur when microdamage accumulates faster than the bone can repair itself. Accurate biomechanical data can support BSI prevention and treatment, typically obtained through motion capture systems using cameras and reflective markers. To accurately track joint and bone movement, markers are placed on the skin over anatomical landmarks. While effective, this method struggles to capture in-shoe foot mechanics because shoes block marker visibility. Footwear significantly alters foot kinematics compared to barefoot gait, which impacts injury risk. This project aimed to enable skin-mounted marker tracking through modified footwear, preserving accuracy during shod walking and jogging. We modified neutral running shoes by cutting 25 mm circular and rectangular holes at 15 anatomical locations defined by the Vogel foot model. Marker trajectories were captured with a 10-camera Vicon Vantage system (Vicon, UK, 100 Hz) and visually compared between barefoot and shod conditions. Trajectories in the shod condition closely mirrored those from the barefoot condition, especially at the hallux segment. Some inconsistencies occurred at the midfoot and forefoot (e.g., medial navicular, medial cuneiform, and proximal first metatarsal) due to marker clustering and occasional occlusion by shoe material. Nevertheless, all markers were visible in at least two frames per trial, and metatarsophalangeal joint motion appeared consistent between conditions, allowing for full gait cycle reconstruction. These results suggest that small, strategic shoe modifications offer a low-cost, low-tech alternative to in-shoe sensors or fluoroscopy, enabling accurate foot motion capture without affecting footwear integrity or natural biomechanics. Future work could include multi-subject validation, automated cutout placement using 3D scans, and testing across shoe types and dynamic activities. Ultimately, understanding how shoes influence foot mechanics may lead to improved footwear choices and training recommendations to reduce BSI risk in runners.

Poster #32

Assessing the Role of Sleep on Emotions and Emotional Control Among Individuals with Schizophrenia

Authors: Damian Jadczak

Summer Program: EREE: Early Research Experience in E-Term

Department: Mathematical Sciences

Advisor(s): Charlotte Fowler

Abstract:

Sleep disorders (SDs) are prevalent in individuals with schizophrenia (SZ), affecting nearly 80% of individuals with SZ. We wish to assess the role of sleep on emotions and emotional control among individuals with SZ. The study employed a two-arm crossover design where 18 participants with SZ were randomized to perturbed or undisrupted sleep. Following sleep, participants were prompted on their smartphones with 10 surveys throughout each day for 3 days about emotions and emotional control, with sliders ranging from 0 to 100. This generated Experience Sampling Method (ESM) data, which was assessed through plots and a linear mixed effects regression model. The model treated perturbed sleep as a fixed effect, with levels of nesting for random effects. From the model, we lack significant evidence that sleep is associated with mood or emotional control responses among individuals with SZ (α=0.05), likely due to the small sample size. However, we identify that perturbed sleep is associated with a 9.6 unit increase in reported sadness, and a 22.4 unit increase in irritation impacting function. While our study leverages a unique design including randomization, future work is needed to explore more complex models and include a larger sample size.

Poster #33

Instrument Testing via Structural Acoustics

Authors: Daniel Cho

Summer Program: EREE: Early Research Experience in E-Term

Department: Mechanical Engineering

Advisor(s): Professor Zhu Mao

Abstract:

What makes a good sounding guitar sound good? Guitarists often assume expensive strings yield better tones, but this belief is rarely backed by measurable data. Sellers mark up prices with reasons like “brand name” and “craftsmanship”, which can easily influence players of all skill levels to overspend on strings that

may or may not offer little to no acoustic benefit. The guitar industry is valued at $19.9 billion and continues to grow at a rate of 7.02% each year, so it's worth asking whether we're paying for sound quality or just clever marketing.

To dig into this, we tested a randomly selected “good” guitar against one that was clearly in worse condition. The lower-quality guitar had visible cracks and warping, which could result in vibration leakage or other distortions during testing. If that's the case, it raises the question of whether spending hundreds more actually improves the playing experience for a beginner or someone who just plays for fun.

We used several methods to excite the guitars and measure their responses, including an impact hammer, modal shaker, accelerometers, and a Laser Doppler Vibrometer (LDV). The vibration data was processed using MATLAB tools like pwelch and Fast Fourier Transform to analyze the harmonic content and identify modal parameters. We kept boundary conditions as close to free-free as possible to avoid skewing the results, so that any differences observed could be tied directly to the instrument's material, construction, and overall build quality.

Poster #34

Using mutagenesis and AI-based predictive protein modeling to examine phospho-regulation of Suv4-20H2 function in mitosis

Authors: Kamala Greenwood, none

Summer Program: EREE: Early Research Experience in E-Term

Department: BCB and BBT

Advisor(s): Amity Manning

Abstract:

Cell division is a tightly regulated process that ensures that the resulting cells each inherit an identical copy of the genome. Mistakes in this process can result in cancerous behavior. During tumor growth, many cancer cells evolve to acquire defects in cell division that permit chromosomes to be mis-sorted, resulting in daughter cells with the incorrect number of chromosomes. Persistent changes in genome content, termed genomic instability, can drive aggressive tumor growth, metastatic behavior, and acquired drug resistance, which may be harder to treat or increase mortality.

To promote proper sorting of chromosomes during division, cells build protein structures, called kinetochores, at tightly compacted regions of each chromosome. The kinetochore serves as an anchor point to which microtubule filaments attach during mitosis to later direct chromosomal movement.

Suv4-20H2 is a protein that promotes the organization of DNA into tightly compacted structures known as heterochromatin through histone methylation. The heterochromatin at the center of chromosomes (known as the centromere) helps to direct the proper recruitment and assembly of key kinetochore components.

While prior work has demonstrated a clear role for Suv4-20H2 in promoting heterochromatin formation, how Suv4-20H2 is regulated to function near the centromere in preparation for kinetochore formation, and not elsewhere in the genome, remains unclear. It was hypothesized that protein phosphorylation regulates Suv4-20H2's ability to interact with centromere proteins and regulate mitotic fidelity. To test this, cell lines where putative phosphorylation sites on Suv4-20H2 have been mutated were examined for the presence of anaphase defects and compared against wildtype control cells. Additionally, AI-based predictive protein modeling and docking were performed between Suv4-20H2 and HP1.

Attention has been placed on Suv4-20H2's function, as it is commonly mis-expressed in cancers. Through understanding Suv4-20H2's regulation and function in mitosis, we hope to gain insight into the processes driving genetic instability in cancer.

Poster #35

Bonding Biological Tissues : Spread Glue and Test Adhesion

Authors: Jessica Amuasi, Jiatai Sun

Summer Program: EREE: Early Research Experience in E-Term

Department: Mechanical Engineering

Advisor(s): Professor Jiawei Yang

Abstract:

The challenge of creating strong and biocompatible adhesion in biological tissues when working in such a wet environment is an ongoing problem in surgical applications. Hydrogels can mimic the soft and water-containing nature of biological tissues and are ideal for desirable adhesion in wound dressings, implants, and systems for drug delivery. The issue with hydrogels is that under physiological conditions, it can be difficult to establish a bond due to the lack of available suitable, non-toxic adhesives. In this research, we sought to study whether we could use chitosan (a biopolymer) to establish a strong and exciting interface between hydrogels and biological tissues.

Chitosan will remain dissolved at an acidic pH. Conversely, when exposed to neutral or basic pH, chitosan will form a physical network of hydrogen bonds and can thus topologically entangle with tissues that contain polymer networks. This is known as topological adhesion. By design, we applied a chitosan solution via mesh between two adherents (hydrogel-hydrogel or hydrogel-tissue) and then applied NaOH (pH ~12) to initiate gelation at the interface. We varied diffusion time and mesh thickness to examine their effects.

Mechanical testing conducted on an Instron tensile tester demonstrated that the strongest adhesion was achieved after a diffusion time of 5 minutes, with a peak detachment force of 0.6 N at an applied strain of 9%. Results also showed the thicker mesh layers lead to reduced adhesion, presumably due to limited contact with the chitosan. Overall, this study demonstrates a tunable and non-toxic means for bonding soft materials,

with promising and useful applications in the surgical and biomedical device fields.

Poster #36

3D-Printed, Endothelialized Hemodialysis Graft-Vein Junction Model

Authors: Eve Dougan, Reyla Williams

Summer Program: REU: Integrated Bioengineering Research

Department: Biomedical Engineering

Advisor(s): Yonghui Ding

Abstract:

End-stage kidney disease (ESKD) affects approximately 808,000 individuals in the U.S., with over 550,000 requiring hemodialysis that depends on repeated vascular access. While arteriovenous fistulas (AVFs) are preferred, synthetic arteriovenous grafts (AVGs), typically made from expanded polytetrafluoroethylene (ePTFE), are used when AVFs are not viable. However, about 50% of AVGs fail after one year due to intimal hyperplasia and restenosis. Existing in vitro models to study these complications often lack structural and functional relevance.

This study aimed to develop a 3D-printed AV graft-vein junction model to investigate endothelial cell (EC) migration and regeneration within AVGs. Two geometries, “straight” and “smooth,” were designed in SOLIDWORKS and printed using a custom μCLIP-based printer with a biodegradable methacrylate poly(1,12-dodecamethylene citrate) (mPDC) polymer ink. Printed models were post-processed, leached, and sterilized. To prevent EC adhesion in the graft region, a 1:10 GelMa barrier was used. Human umbilical vein endothelial cells (HUVECs) were seeded in the venous portion at 25,000 cells/cm^2. Samples were fixed on days 1, 3, and 7 for immunofluorescent staining and confocal imaging.

Results showed EC survival, proliferation, and migration into the graft under static conditions. Both geometries supported increasing migration distances over time, with the straight model exhibiting significantly greater EC migration by Day 7 ($p < 0.05$). The curved path of the smooth model likely limited migration due to increased travel distance.

This work highlights the potential of 3D-printed junction models to evaluate graft design. Future directions include incorporating physiological flow, microtopography, and coculture with smooth muscle cells to better mimic in vivo conditions. Due to the biodegradable nature of mPDC, this model may contribute to the development of tissue-engineered vascular grafts for long-term hemodialysis access.

Poster #37

TNF-α Disrupts Cooperative vWF Anchoring by P-selectin and Endothelial Glycocalyx Heparan Sulfate

Authors: Camden Holm, Pranav Ramaswamy, Zakary Raymond

Summer Program: REU: Integrated Bioengineering Research

Department: Biomedical Engineering

Advisor(s): Solomon A. Mensah

Abstract:

Sepsis, a life-threatening inflammatory condition, is increasingly recognized as a trigger for coagulopathy and stroke, with sepsis-associated coagulopathy linked to a 43% increase in stroke risk per 3-point rise in risk score (Ishikura et al. , 2014; Shao et al., 2019). The endothelial glycocalyx (GCX), a sugar-protein matrix on vascular endothelial cells, regulates coagulation by anchoring molecules like heparan sulfate (HS), P-selectin (PS), and von Willebrand factor (vWF). Under homeostasis, HS binds and immobilizes vWF on the endothelial surface; however, inflammation-driven GCX degradation may cause premature release of ultra-long (UL) vWF into circulation, increasing thrombotic risk.
To investigate this, we developed an in vitro model using Human Lung Microvascular Endothelial Cells (HLMVECs) to simulate healthy and septic conditions. First, optimal GCX formation was determined by culturing cells for 2–4 days at densities of 75k and 150k, showing significantly greater GCX staining than 1-day cultures. Next, physiological shear stress (12 dynes/cm^2 for 6 hours) was applied using a parallel-plate flow chamber, which enhanced GCX and related marker expression (HS, PS, vWF) relative to static controls. Finally, cells were treated with TNF-α (30 ng/mL) for 2 hours, modeling septic conditions.
This study presents a foundational in vitro model for investigating sepsis-induced endothelial glycocalyx (GCX) dysfunction. Shear-induced GCX formation was successfully validated by increased expression of HS, PS, and vWF, and initial TNF-α exposure selectively affected HS without significantly altering PS or vWF levels.
While a trend toward increased HS intensity was observed, the lack of consistent GCX disruption highlights the need for stronger or prolonged inflammatory stimuli. Future refinement will include higher TNF-α doses, extended exposure periods, and endotoxin co-treatment to more accurately mimic septic conditions. Additional quantification using qPCR, ELISA, and western blotting will further elucidate GCX shedding and vWF dysregulation, providing insights into thrombotic complications and septic stroke risk.

Poster #38

Deciphering the Roles of RNA Processing Proteins in M. smegmatis rRNA Maturation

Authors: Aiyina Meng

Summer Program: MQP

Department: Biology and Biotechnology

Advisor(s): Scarlet Shell

Abstract:

Tuberculosis (TB), the world's number one cause of death from a single infectious agent, is caused by the pathogen Mycobacterium tuberculosis. To develop more effective treatments for the disease, a deeper understanding of the bacteria's essential processes, including ribosome biogenesis, is needed. In bacteria, ribosomal RNA (rRNA) is transcribed as a single polycistronic precursor and requires cleavage by ribonucleases (RNases) to give mature products for ribosomal assembly. To investigate the activity of these enzymes in vitro, we expressed and purified recombinant Mycobacterial RNase E and RNase III from E. coli expression strains. Expression conditions were optimized through expression tests, and proteins were purified using affinity and size exclusion chromatography. We found that while full-length RNase E expressed best when induction was limited to 4 hours at 28°C due to the instability of its intrinsically disordered domains, RNase III expressed best when induced at 28°C overnight. Future directions include performing cleavage assays on RNA to quantify the activity of the RNases and combining RNase E, RNase III and other interacting proteins with the rRNA transcript to exhibit their activity and interactions.

Poster #39

Assessing Bubble Continuous Positive Airway Pressure (bCPAP) Device Performance Across Environmental Factors

Authors: Fiona Gillis

Summer Program: REU: Integrated Bioengineering Research

Department: Biomedical Engineering

Advisor(s): Dirk Albrecht, Soloman A. Mensah, PhD.

Abstract:

Reliable performance in diverse environmental conditions is essential for medical devices made for low- and middle-income countries (LMICs). Birth complications in preterm babies are a leading cause of fatality in children under the age of 5, and Bubble Continuous Positive Airway Pressure (bCPAP) can help reduce this issue.
This study evaluates the AirBaby bCPAP device, developed by Therapeutic Innovations, under a range of environmental conditions. The device was tested in ambient temperatures from 18–40 °C using an environmental chamber. Tilt and vibration were assessed using a 3-axis accelerometer and real-world transport in a car over 200 miles.
Airway temperature stayed within ±0.6 °C of the 37 °C setpoint across 18–37 °C ambient temperatures. At 40 °C, the lack of cooling caused temperatures to exceed the target. In dynamic temperature tests, the device recovered within minutes, with heating recovering faster than cooling. Power use decreased as ambient temperature rose.

The device maintained airway temperature up to 40° tilt in each direction. During vibration testing, the airway temperature stayed within ±1.0 °C of the setpoint for 92.5% of a 5-hour drive, reaching a peak of 1.31 g-force. A brief temperature spike occurred due to a kinked airway tube.
These results indicate the AirBaby bCPAP device performs reliably in realistic LMIC environments. It maintains setpoint temperature, withstands tilt and vibration, and consumes less than 50 W to enable extended battery life.

Poster #40

Modulating Pressure Fluctuations in a Low-Cost Bubble Continuous Positive Airway Pressure Device

Authors: Elizabeth Fio (MS), Jailyn Rivera Rodríguez

Summer Program: BME REU program

Department: Biomedical Engineering

Advisor(s): Solomon Mensah, Dirk R. Albrecht

Abstract:

Out of the 15 million preterm neonates born annually, less than 10% survive in low-to-middle income countries (LMICs). A leading cause of mortality and morbidity for premature infants is the development of respiratory distress syndrome (RDS). Bubble Continuous Positive Airway Pressure (bCPAP) therapies are one of the most prominent treatments to counteract lung collapse and improve gas exchange in preterm neonates with RDS. However, commercial bCPAP devices are often inaccessible to LMICs due to expensive single-use consumables. The AirBaby is a low-cost, energy efficient bCPAP device developed to reduce the economic burden on LMICs healthcare facilities by limiting the number of consumables required to treat multiple patients. Its reusable, sterilizable airway tubes feature thicker, more durable walls, resulting in lower internal compliance and the potential for greater amplitude of pressure fluctuations. This project evaluated the contributions of airway circuit elements on the mean pressure, amplitude, and frequency of pressure fluctuations at the nasal interface. Phase I examined the contribution of the AirBaby's air source, bubble chamber, and humidifier bubbler on the airway pressure fluctuations. Phase II investigated the effects of tubing compliance on the amplitude and frequency of pressure fluctuations and sought to identify which section of the airway circuit contributes most to pressure fluctuations at the nasal interface. A silicone Infant Test Lung and a provisional nasal cannula were used to simulate the infant's lungs. Eight configurations of Fisher & Paykel and AirBaby airway tubes and bubble chambers were used to simulate different internal compliance conditions. Phase III assessed the effect of adding external compliance (via a rubber balloon) placed at the inspiratory tube, expiratory tube, and both locations. The results highlight that the amplitude, waveform, and frequency of bCPAP pressure oscillations can be regulated by altering tubing compliance at the expiratory section of the airway circuit.

Poster #41

Deep Alloy: A Model for Alloy Property Prediction

Authors: Nicolas Adrian, none

Summer Program: not part of summer research program

Department: Mechanical and Materials Engineering

Advisor(s): Yangyang Fan, Yu Zhong

Abstract:

Current methods for the discovery of new materials with desirable characteristics are somewhat archaic and costly. They require the purchase of expensive raw materials, the operation of furnaces, arc melters and/or other costly instruments, as well as the many hours of experimentation needed to determine the product's material properties. This poster presents a new machine learning (ML) based approach to discovering new materials that significantly reduces the cost, timeframe, and amount of skilled labor necessary. The research was conducted on the basis of a novel ML model called Deep Alloy, trained to produce metal alloy microstructures when given an input set of parameters including elemental composition and cooling rate. With the direct causality between microstructure and material properties, many currently existing models can be used in conjunction with Deep Alloy to complete this fully automated material discovery pipeline. To test the robustness of the model's architecture and how it fairs against current experimental methods, the model was trained on a multitude of Aluminum-Silicon (Al-Si) alloy data and then asked to produce 64 microstructures for the A356 Al-Si alloy (a widely used alloy) at 7 different cooling rates. With these microstructures, the average secondary dendrite arm spacing (SDAS) of the alloy for each cooling rate (CR) could be calculated, and then an SDAS vs CR curve could be constructed. This could then be compared to curves for the A356 alloy in current literature to verify accuracy of the model. While this curve hasn't yet been constructed from these generated microstructures, it is clear from visual observation that the model clearly understands the negative correlation between SDAS and CR. Future work will aim to fully construct this SDAS vs. CR curve so that the model can be fully characterized for its accuracy in this area of material discovery.

Poster #42

Modeling Glial Cell Dynamics Post Ischemic Stroke

Authors: Madeline Gagnon, none

Summer Program: Manning/Lesser Fellowship

Department: Mathematical Sciences

Advisor(s): Andrea Arnold

Abstract:

Stroke is a leading cause of death worldwide, and ischemic stroke is the most common type. Knowledge of the underlying cell dynamics and immune response following stroke is critical for developing treatment strategies. The neurovascular unit (NVU) connects the central nervous system and its vasculature. Microglia and astrocytes are components of the NVU that play pivotal roles in post-stroke inflammation and repair. Both cell types experience two activation phenotypes: neuroprotective and neurotoxic. This research contributes a new mathematical model describing the dynamics of microglial and astrocyte activation post ischemic stroke. We develop a system of four differential equations with compartments representing the neuroprotective and neurotoxic glial cell types. The model uses logistic equations to represent cell activation rates, with parameters chosen to follow biological trends observed in experimental studies. The resulting model indicates that the neuroprotective phenotypes peak early following stroke and then decline to a steady state, while neurotoxic phenotypes increase more gradually. Additionally, astrocyte activation is slightly delayed compared to microglial activation. This model provides initial insights into the long-term glial cell behavior after stroke.

Poster #43

Molten-salt-etched Chlorine Terminated Ti3C2Cl2 MXene shows Atmospheric Stability and High Carrier Transport

Authors: Kate L. Pogge, Collin M. Shuff

Summer Program: REU: Functional Materials

Department: Mechanical and Materials Engineering, Chemistry and Biochemistry, Physics

Advisor(s): Kateryna Kushnir Friedman, Ronald L. Grimm, Lyubov V. Titova

Abstract:

MXenes are 2D nanomaterials that exhibit metallic-like properties such as high conductivity and rapid conversion of optically absorbed energy to thermal energy. Ultrafast photoactivation suppresses conductivity in the THz region of the electromagnetic spectrum, however the relationship between MXene chemical termination and the resulting optoelectronic properties is currently unclear. The present study investigates a molten-salt conversion of Ti3AlC2 MAX to MXene and subsequent surface-chemical derivatization conducted under inert atmospheres to establish relationships between surface chemical species and conductivity, photoconductivity, and phonon behavior in the THz region. X-ray photoelectron spectroscopy confirmed the synthesis of MXenes and quantified both MXene oxidation states and successful surface derivatization. Time-domain THz spectroscopy characterized MXene conductivity as well as transient photoconductivity. We discuss relationships between MXene surface chemistry and the resulting conductivity and transient photoconductivity with a view towards applications in energy storage systems and flexible electronics.

Poster #44

Switching Up SLiMs – Investigating ΔIC2/CO1as a Kek5 SLiM Regulator

Authors: Taina Marigny

Summer Program: CLIMB@WPI

Department: Biology/Biotechnology

Advisor(s): Joseph Duffy

Abstract:

(DRAFT)
The transmembrane protein, Kekkon 5, exhibits a high level of expression in the embryonic central nervous system, modulates the Bone Morphogenetic Protein (BMP) signaling pathway and remains broadly expressed throughout development in Drosophila melanogaster. Structurally, Kek5 has a disordered intracellular (IC) region containing an evolutionarily conserved short linear motif (SLiM), called IC2/CO1, that is analogous to the Deleted in Colorectal Cancer (DCC) P1 sequence known to guide axon development in humans. Similar to DCC, Kek5's ability to perform its' response interactions appears to be dependent upon the prevalence of certain intracellular motifs like P1. Most notably, previous work has shown that the Kek5 intracellular IC2/CO1 SLiM is necessary to prevent lethality when Kek5 is misexpressed. However, additional deletions of SLiMs IC4 and IC5 may have the potential to restore Kek5ΔIC2 from aberrant lethality. Therefore, it is suspected that the IC2 SLiM typically regulates IC4/5, and without it, IC4/5 are detrimental to Kek5 function. Our goal is to determine how the IC2 SLiM regulates Kek5 and assess the structure-function significance of SLiMs in the disordered IC region. First, to determine the potential relationship between IC2 and IC4/5, we created two new Kek5 deletion variants, Kek5Δ245 and Kek5Δ345, using site-directed mutagenesis. Then, to further characterize the effect of IC2 deletion, we created a stable stock of deltaIC2 and bred new transgenic lines of Kek5ΔIC2 misexpressed in complementary cellular developmental patterning pathways. Additionally, we assessed the overall structural significance of Kek5 SLiMs by creating protein predictions of Kek5 SLiM deletion variants. By determining the functional mechanisms of Kek5 SLiMs, we seek to expand the understanding of complex developmental signaling pathways.

Poster #45

Do Musicians and Non-Musicians Process Musical Emotions Differently?

Authors: Samin Nihad

Summer Program: STAR Fellowship: Summer Training in Arts & Sciences Research

Department: Data Science

Advisor(s): Scott Barton

Abstract:

We all know music can evoke powerful emotions, but does musical training change how we experience those feelings? This study investigates whether musicians and non-musicians process musical emotions differently. Using existing data from 200 people (100 musicians, 100 non-musicians), I examined responses to 116 short musical clips specifically composed to evoke happiness, sadness, fear/anger, and serenity. Through analysis in Python, I compared how intensely each group felt about the music, how accurately their emotions matched the intended emotions, and how their mental health influenced these experiences. Musicians reported stronger emotional reactions, particularly to joyful music, and expressed emotions that matched more with what the music aimed to convey. Visualizing the data showed musicians' responses clustered in positive, energetic ranges, while non-musicians' reactions were more varied. Notably, musicians' emotional responses were more affected by their mental health; higher anxiety amplified feelings of sadness, while depression weakened serenity. Non-musicians' reactions showed a smaller influence from these factors.
These results suggest that musical training may reshape how we emotionally connect with music. The study opens new questions about why these differences exist and how other factors, like musical style or cultural background, might play a role. Future studies could examine whether these patterns hold across cultures, genres, and age groups.

Poster #46

A Better Molecular Mimic of Carbonic Anhydrase for Concrete Production?

Authors: Andrew Raymond, none

Summer Program: LaPre Fellowship

Department: Chemistry

Advisor(s): Ronald Grimm

Abstract:

Concrete is one of the most widely utilized materials on the planet, with over four billion metric tons being produced every year resulting in 8% of total anthropogenic global CO2 emissions. The dependence on the modern construction sector on this material is not projected to diminish within the near future, driving research towards the reduction of concrete's environmental footprint. We recently demonstrated that carbonic anhydrase (CA) rapidly catalyzes the formation of carbonate in concrete and cementitious materials, leading both to new materials, and crack healing in existing materials. However, the enzyme is only viable for two weeks, which motivates research into alternatives that replicate the catalytic carbonate formation with long-term pH and thermal stability. Here we researched zinc cyclen, 1,4,7,10-tetraazacyclododecane zinc(II), and selected derivatives for their carbonate production under extreme conditions of alkaline pH and high temperatures relevant to concrete curing. We explore build-then-ligate and ligate-then-build derivatization pathways for the synthesis of zinc N-tetrabenzylcyclen, with a view towards reproducing both the Zn2+ active site and the CA superstructure that orients the H2O and CO2

precursors and facilitates H+ transport away from the nascent HCO3– species. Nuclear magnetic resonance spectroscopy validated successful synthesis of each precursor. We discuss the results in the context of improving molecular mimic libraries and developing stronger, carbon-sequestering cementitious materials. Future work will include bubbling a dilute concentration of CO2 through a solution of derivatized catalyst to establish relative rates of carbonate formation for each catalytic species by monitoring the production of H+ through carbonate formation.

Poster #47

Phylogeography and Invasion History of Virile Crayfish in North America

Authors: Lillian Hanly

Summer Program: Spencer Fellowship

Department: Biology and Biotechnology

Advisor(s): Lauren Mathews

Abstract:

The virile crayfish, Faxonius virilis, is widespread in the central U.S. and has spread across the eastern seaboard, threatening biodiversity and native freshwater ecosystems. The invasion history and phylogeography of virile crayfish are understudied. The goal of this research was to use DNA from Faxonius virilis crayfish specimens collected in their native range (midwestern U.S.) and their non-native range (primarily eastern U.S.) to gain insight into the mechanisms by which invasive species spread. We extracted DNA from crayfish individuals and amplified two mitochondrial genes (COI and 16S rRNA) and one nuclear gene (GAPDH) through PCR (polymerase chain reaction). Their sequences were analyzed to identify spatial patterns of genetic differences among crayfish samples. These sequences will be added to the data set of MQP team Manning et al. (2025) to gain more insight into the invasion pattern of F. virilis and to determine which of the three major clades identified by Manning et al. (2025) is genetically consistent with F. virilis. This information can be used to understand and minimize the spread of invasive species to protect native ecosystems. We acknowledge and thank Dr. Susan Spencer and the Spencer Undergraduate Research & Lab Enhancement Initiative for funding this research.

Poster #48

Tracking and Visualizing Foot Center of Pressure During Loading in a Cadaveric Model

Authors: Julia M. Nicolescu, Reynaldo Rodriguez

Summer Program: REU: Integrated Bioengineering Research

Department: Biomedical Engineering

Advisor(s): Karen L. Troy

Abstract:

Bone stress injuries (BSIs) occur due to an accumulation of microdamage within the bone. Metatarsals (MTs) are common injury sites that represent 38% of BSIs in college athletes and 58% of BSIs in the military. Currently it is not understood why some runners get BSIs and some don't. Studies found the center of pressure (COP) progression to be useful to understand how loads are transmitted within the foot, finding that specific deviations and characteristics of COP on the foot can be contributing factors to higher risk of BSI. In this study we use a robotic actuator to move five cadaveric tibia-to-toe tip specimens through robotically prescribed dorsiflexion/plantarflexion (DPF), varus/valgus alignment (VVS), and external/internal rotation (EIR) while applying 25% body weight. Three 6-degrees-of-freedom load cells were placed beneath the calcaneus, MT1-2, and MT3-5 respectively. Four underfoot conditions were observed in these motions: (1) flat, (2) 45° toe wedge windlass mechanism under phalanges, (3) 0.5-inch block under MTs 1-2, (4) 0.5-inch block under MTs 3-5. Loadc cell data were processed to calculate the COP progression over time of each load cell during the different motions and underfoot conditions, these being used to calculate a weighted average COP to represent the COP progression of the whole foot. We found that COP progression shifts anteriorly (towards the forefoot) during windlass conditions in all 3 motions. COP shifted towards MTs 1-2 when the block was paced under MTs 3-5 and the same occurred vice versa. COP deviated more laterally and medially during VVS motion. We conclude that COP progression shifts in position and trajectory depending on the motion and underfoot condition.

Poster #49

Clocking Death: Decoding Death Time from Circadian Gene Rhythms

Authors: Haruku Aono, Kayla Conrad, Steffi Dorothy

Summer Program: REU: Applied Artificial Intelligence for Advanced Applications

Department: Data Science

Advisor(s): Chen Fu, Ryan Logan, Chun-Kit Ngan

Abstract:

Circadian genes play a crucial role in regulating daily physiological and behavioral rhythms, with over 2000 genes exhibiting rhythmic expression patterns. Dysregulation of these genes is associated with various medical conditions, highlighting the importance of understanding the relationship between circadian gene expression and neurological/neuropsychiatric phenotypes. In this context, the accurate determination of the Time of Death (TOD) is a crucial factor. However, accurately determining TOD is often challenging due to unrecorded or inaccurate documentation, highlighting the need for a reliable TOD-predictive system. Our

previous approach has relied on Deterministic Machine Learning (DML) models, which produce single-point TOD estimates. These predictions fail to account for inherent model and data uncertainty in gene expression datasets. To address this, we propose leveraging Probabilistic Machine Learning (PML) models that predict the conditional probability distribution of TOD given uncertain input data. Unlike DML models that provide single-point estimates, our PML models capture uncertainty at the per-sample level through predictive distributions. Our experiments identified the Gaussian Energy-Based Neural Network as the most effective model, evaluated using probabilistic performance metrics, including Negative Log-Likelihood, Continuous Ranked Probability Score, and Expected Calibration Error. We also optimized data preprocessing strategies to enhance model performance. Notably, our experiments not only validate predictions from both DML and PML models but also reveal potential inaccuracies in previously recorded and deterministically predicted TODs, highlighting the importance of probabilistic approaches in capturing uncertainty in gene expression datasets.

Poster #50

Identifying Interactors of SCD1 in the Moss Physcomitrium patens

Authors: Edward Chocano-Coralla, Natalie Martinez, Rachel Maurice, Staša Roganović

Summer Program: LaPre Fellowship

Department: Biology & biotechnology

Advisor(s): Luis Vidali, Sebastian Bednarek

Abstract:

Shortened version of the abstract - PI needs to review my current abstract before submission, and he usually doesn't come in until the afternoon. Will resubmit form with final abstract.

Polarized cell growth in plants, specifically tip growth, is known to be driven by vesicle trafficking-mediated exocytosis. The plant-specific Stomatal Cytokinesis Defective (SCD) Complex plays an important role in cell growth and division. However, its interactors are not known in moss. This project aimed to identify interactors of the subunit SCD1 using immuno-isolation (pulldowns) and proximity labeling (TurboID). Our mass spectrometry results indicate interactions between the exocyst complex, endocytic pathway components, and MyTH1, a putative component of the SCD complex in A. thaliana. In addition, new moss lines were generated for the expected interactors of the SCD complex (mEGFP-RabE1, MyTH1-KO).

Poster #51

Altering a Magnetic Field Using Concentric Halbach Arrays

Authors: Adam Hueil

Summer Program: EREE: Early Research Experience in E-Term

Department: Mechanical Engineering

Advisor(s): Giovanni Pittiglio

Abstract:

While magnetic fields have a wide range of applications, there are only two methods of creating a magnetic field that are utilized today: electromagnets, which create a magnetic field by running a current through coiled wire, and which are expensive to create and operate but can be turned on and off at will, and permanent magnets, which are significantly cheaper, but generate their magnetic field constantly, limiting their utility. Our goal in this project is to generate a powerful, homogenous, and cost-effective magnetic field that, despite using permanent magnets, is able to be turned on and off at will. In order to accomplish this goal, we created rings housing 3 concentric Halbech Arrays, magnets specifically oriented so that they create a strong uniform field in a single direction, which can rotate independently of each other. By measuring the magnetic field within these rings using a Gauss Meter, we were able to determine that when the concentric rings were aligned, the field they created was uniform, but when the rings were aligned such that one was the inverse of the other, the magnetic field in the measured area dropped to zero. Thus, by rotating these rings, we were able to create a strong homogenous magnetic field out of permanent magnets that could be turned on and off at will, capitalizing on both the cost-effective nature of permanent magnets and the magnetic field variance of electromagnets.

Poster #52

Productivity Managers and the effects of Gamification on Cognitive Efficiency

Authors: Chloe Polit

Summer Program: STAR Fellowship: Summer Training in Arts & Sciences Research

Department: Computer Science

Advisor(s): Lane Harrison

Abstract:

Gamification has emerged as a popular strategy to enhance user motivation and emotional satisfaction across platforms. But how effective is gamification in improving productivity and user engagement? This project investigates that question through the design and evaluation of a web-based productivity manager centered on minimalist visual and interaction design. The study analyzes emotional response, perceived productivity, and motivation across both gamified and non-gamified versions of the interface. It examines how gamified variables, such as progress bars and reward cues, influence the overall user experience of platforms. Findings highlight which gamification features most strongly impact motivation in productivity-focused tools and suggest their broader applicability across platforms with different goals. Results indicate

that even lightly integrated gamified elements can significantly enhance user engagement and satisfaction. Future research will explore how platform purpose and interface style shape the visibility, effectiveness, and long-term impact of gamification.

Poster #53

pH-responsive, vancomycin-loaded liposomes for treatment of Staphylococcus epidermidis

Authors: Alexandra Harrison, Emily Lei, Patryck Michalik, Sydney Packard, Scarlett Xu, Winnie Yang

Summer Program: EREE: Early Research Experience in E-Term

Department: Chemical Engineering

Advisor(s): Christina M. Bailey-Hytholt, Elizabeth J. Stewart

Abstract:

Staphylococcus epidermidis is one of the most common causes of hospital-acquired infections due to biofilm formation on medical device surfaces. Biofilms are communities of bacteria encapsulated in an extracellular polymetric substance matrix and have reduced susceptibility to antibiotics, such as vancomycin. During biofilm development, biofilms develop pH gradients within their structure. Liposomes are nanoparticles used in drug delivery and can be engineered to be pH responsive. Here we aim to formulate liposomes that have targeted delivery to S. epidermidis biofilms. Liposomes were formulated by self-assembly using an extruder and eight different compositions were tested. Key components of the liposomes were MC3, helper lipids (DOPC and DSPC), and cholesterol. A promising liposome formulation was identified through varying mole percentages of MC3 and helper lipids. Liposomes were added to pH buffers ranging from 3.5 to 8 to evaluate the effect of pH on the liposome's characteristics. Liposomes comprised of 65 mole percent MC3, 25 mole percent DSPC, and 10 mole percent cholesterol were found to be 151.7 nanometers (pH 7.46) with a zeta potential of –2.12 millivolts (pH 6.8). There was a notable size increase correlated with decreasing pH, specifically at pH 5.5 to 292.7 nanometers. Zeta potential was neutral at pH 5.5 and positive at pH 5, indicating a likelihood of releasing the payload of the liposomes. Increasing the concentration of MC3, from 50 mole percent to 65 mole percent, resulted in a decrease in the zeta potential for neutral liposomes. When comparing the two helper lipids, DOPC and DSPC, DSPC is more suitable for vancomycin delivery as liposomes formed with DSPC protonated within the pH region of the biofilm. Through changing the concentrations of different lipids, liposomes can be formulated to protonate at a specific pH within the S. epidermidis biofilm range, allowing better targeted drug delivery.

Poster #54

Bridging People and Algorithms: Woman-In-The-Loop Mentorship Matching

Authors: Nina Klimenkova, Angela Santos

Summer Program: REU: Applied Artificial Intelligence for Advanced Applications

Department: Computer Science

Advisor(s): Roee Shraga

Abstract:

Despite the proven impact of good quality mentorship, the process of finding the right mentor remains an underexplored challenge. This is especially evident for underrepresented groups such as women. To address this issue, we propose an AI-driven mentorship matching system that is refined iteratively via Human-in-the-Loop (HITL) feedback to enable personalized and equitable pairings. We designed a survey-based data collection process, followed by automated filtering to validate completeness and quality. To address the lack of data, we further generated synthetic data profiles based on survey structure using three different approaches: zero-shot learning with DialoGPT and GPT-2 and in-context learning with GPT-2. We evaluated the quality of the dataset, comparing the diversity, naturalness, coherence, and realism and predicting which method was used to create the profile for a random set. We employ a natural language processing (NLP) model, BERT, to assess mentor-mentee compatibility using both classification and regression. The classification problem determines whether a given mentor-mentee pair is a good or bad match (binary outcome), while the regression problem predicts the exact match score, reflecting the strength of the match. Model experiments include LLM scoring with embeddings, and advanced BERT-based fusion approaches. Results indicate GPT-2 with zero-shot learning is sufficient to generate synthetic datasets, with the highest averages for each category. Additionally, BERT fusion models outperform LLM scoring, with early fusion achieving the highest classification accuracy and F1 score with 0.714 and 0.727 respectively. Late fusion provides superior regression performance with the lowest MSE at 0.888 and highest spearman correlation at 0.648. These results show potential in combining AI with human feedback to improve match accuracy and create more effective and fair mentorship systems. Future work will include obtaining and utilizing larger, more diverse datasets, integrating HITL, developing matching algorithms, and launching the official survey.

Poster #55

Lepidocrocite TiO2 “1DL” Adsorbs Chemical Warfare Agent Simulants

Authors: Abigayle Fadgen, none

Summer Program: Summer Research

Department: Chemistry

Advisor(s): Ronald Grimm

Abstract:

Exposure to hazardous chemicals threatens those in the line of defense, healthcare workers, and civilians. To solve this ongoing issue, new materials are being studied in order to keep those in contact with these

dangerous chemicals safe. Lepidocrocite TiO2, also known as 1DL, is a one-dimensional nanomaterial that readily adsorbs polar molecules, and shows particular selectivity for G-series chemical warfare agents. However, the nature of this 1DL-adsorbate interaction is not well understood, and quantifying reactive adsorption vs physisorption should further improve 1DL's decontamination (decon) abilities.
The present study investigates the interaction between a gas-phase chemical warfare agent (CWA) simulant with a 1DL surface with time-resolved FTIR spectroscopy over a two-hour period. The resulting spectra reveal vibrational modes ascribed to the CWA simulant, the loss of an organic cation from the 1DL material, as well as new features that suggest a reactive adsorption and possible degradation of the CWA simulant. We interpret these results in the context of possible adsorption modalities and implications for future CWA decon applications. Special thanks to Josh Uzarski, the CCDC Soldier Center, and Michelle Barsoum for their contributions to this research.

Poster #56

The effect of an aerial release on modeling radionuclide resuspension

Authors: Haley Day

Summer Program: STAR Fellowship: Summer Training in Arts & Sciences Research

Department: Physics

Advisor(s): David Medich

Abstract:

A strong model describing environmental radionuclide resuspension is critical in assessing health risks posed to populations affected by nuclear disasters. The current empirical model relies on historical data such as dirty bomb tests and the Chernobyl meltdown. However, these datasets vary significantly in experimental and environmental factors. A key source of variability is the height of radionuclide release. Radionuclide resuspension models that incorporate airborne releases may mistake initially suspended particles as resuspended particles, in turn overestimating the resuspension factor. My research investigates how radionuclide resuspension is affected by airborne releases relative to surface releases. Non-radioactive europium oxide, a chemical analog of common nuclear disaster products, was used to test radionuclide resuspension. Six resuspension chambers were constructed using acrylic tubes, cement brick bases, and air sampling systems. In each chamber, 2 grams of europium oxide were either placed onto the concrete or released from a height of 0.25 meters. Resuspended particles were collected onto air filters over a 12-day period using air pumps running at 2 liters per minute. Filters were retrieved and replaced daily. Neutron activation analysis was employed to determine the europium oxide mass on the filters. However, following irradiation, the samples became contaminated with radioactive sodium-24, compromising the data. Resuspension testing is ongoing to produce valid data. Results will be submitted to the Health Physics Journal to support research in radionuclide resuspension.

Poster #57

Photothermal properties of Ti3C2Tx and silk fibroin composite films

Authors: Priyal Anand, Molly Busby, Shaylie Lagasse, Isaac Levine, Dawei Liu, Rachael Speckhard

Summer Program: REU: Functional Materials

Department: Biomedical Engineering, Physics

Advisor(s): Jeannine Coburn, Kateryna Friedman, Lyubov Titova

Abstract:

MXenes, a class of two-dimensional nanomaterials, has attracted much attention in the field of biomedical engineering. Ti3C2Tx, a type of MXene, has demonstrated excellent photothermal conversion properties, making it a promising candidate for drug delivery and antimicrobial applications. However, Ti3C2Tx decays rapidly via oxidation under ambient conditions. Prior work by Krecker et al., showed that silk fibroin can be used to stabilize the aqueous Ti3C2Tx colloidal solutions (1). However, the research of Ti3C2Tx's properties after forming into composite silk materials (e.g., films) has been limited. In a previous study, we showed that silk fibroin-MXene composite films deposited from aqueous colloidal solutions retained most of the AC conductivity in the THz range while the DC conductivity was significantly reduced (2). In this study, we will report on the photothermal properties of the MXene silk composites and how post processing affects those properties. We used an infrared (IR) thermal imaging camera (3) to investigate the thermal properties after exposing the samples to collimated broad spectrum light. Additionally, Time Resolved Terahertz Spectroscopy (TRTS) was used to characterize thermal relaxation in femtosecond scale after optical excitation by monitoring their optically induced thermal changes to THz conductivity. Using TRTS, we have found that samples with higher silk to MXene ratio decay faster than the samples with lower ratio. Using IR in the second time scale, there was no difference in the decay times when comparing samples with MXene and silk to samples with only MXene. In both cases, post processing did not affect relaxation times.

Acknowledgements: This research was supported by the National Science Foundation through the Research Experiences for Undergraduates (REU) program under Award No. NSF REU 2447096 and, in part, with funding from the Gapontsev Family Collaborative Venture Fund. We thank Andrew Fitzgerald, Nika Gegechkori and Laura Londono Fandino for the equipment training.

Poster #58

Immigration Policy Analysis with Generative AI: Creating accessibility through storytelling and video format

Authors: Jim A. Murcia Calderon, none

Summer Program: MQP

Department: Computer Science

Advisor(s): Crystal Brown, Oleg Pavlov

Abstract:

Policymaking is an important aspect of any nation involving a vast number of interconnected variables, which often leads to a slow policymaking process. Modeling how policy works can present even more barriers for researchers. However, artificial intelligence (AI) might help us model policy changes. A team of interdisciplinary undergraduate students, working on their senior thesis at WPI under the leadership of four faculty advisors, trained an AI model to track and model the effects of immigration policy.

Their findings showed potential for using AI to model policy performance, but more importantly, that the project was ready to be taken further. It only needed higher visibility and higher public engagement.

In order to help showcase and spread awareness of the trained model, the information was presented in a short video abstract format. The video presented the original work with graphics and engaging photos that make the original project more palpable to the public. More importantly, it condensed all the key information of the project into under 6 minutes without losing any important meaning. The video format allowed for increased accessibility and engagement, offering a starting point for further discussion, improvements, and implementation.

Poster #59

DETA is readily allylated, modifying "saldeta"approach towards heavy metal capture

Authors: Abigail Cieniawa

Summer Program: STAR Fellowship: Summer Training in Arts & Sciences Research

Department: Chemistry

Advisor(s): Ron Grimm

Abstract:

Heavy metal ligation has applications in energy, medicine, water filtration, and more. A new synthesis combining salicylic aldehyde (sal) / diethylenetriamine (deta) into "saldeta" was discovered, this molecule has extremely high selectivity and modification potential for metal raking. This study asked if saldeta can be coupled with a silane, and if so, will this molecule tether to non-traditional surfaces? To couple with the silane, a reaction between deta and allyl bromide was carried out under basic conditions, liberating hydrobromic acid, followed by a Schiff base reaction with sal to form allyl saldeta. To test functionalization,

Chloropropyl(triethoxy)silane was tethered to silica powder in ethanol under acidic conditions. Chloropropyl(trichloro)silane was tethered to 1DL TiO2 in both ethanol and toluene separately under neutral conditions. The allyl saldeta was characterized by nuclear magnetic resonance (NMR) spectroscopy, revealing the synthesis was successful, with one unintended side product that can be discarded. The Silane attachments were characterized by X-ray Photoelectron Spectroscopy (XPS). The Silica was functionalized readily, but with room to modify conditions to yield better surface coverage. The TiO2 was functionalized readily in ethanol, again with room to modify and improve surface coverage, but toluene as a solvent resulted in the silane polymerizing and covering the surface without attaching. The next phase of this project is to perform a hydrosilation reaction between triethoxysilane and allyl saldeta, which will result in a silane that can then be functionalized onto a surface. Once this can be synthesized in significant quantities, ligation testing can begin. I would like to thank the WPI STAR for their funding that allowed me to carry out this research over the summer, as well as Amanda Haner for her background work on this project.

Poster #60

Initial Attachment of Staphylocccus aureus to Surfaces in a Fluidic Channel

Authors: Sophia Aikins-Hill, none

Summer Program: STAR Fellowship: Summer Training in Arts & Sciences Research

Department: Biochemistry

Advisor(s): Christopher R. Lambert

Abstract:

Initial results are presented from research that investigates bacterial adhesion, the first step in biofilm formation. Utilizing an innovative flow-through channel to investigate adhesion as a function of surface chemistry, it was found that hydrophobic surfaces were the most effective at reducing Staphylocccus aureus attachment. The ultimate outcome of this work will be the fabrication of surfaces that inhibit S. aureus biofilm formation, with applications in healthcare and food safety. At the same time, working in collaboration with Professor Gatsonis in Aerospace Engineering, the fluidic dynamics of the bacteria in close proximity to the surface is being modeled with the ultimate goal of predicting surface resistance to biofilm formation.

Poster #61

Creating a Virtual Reality (VR) Library of Landmark Buildings in the Northeastern Region

Authors: Prince Nanakobi Jr

Summer Program: EREE: Early Research Experience in E-Term

Department: Computer Science

Advisor(s): Professor Shichao Liu

Abstract:

This project was aimed to bring places that people couldn't visit to them instead. Our goal was to help spread the historical and architectural significance of locations they may have never been able to go to before. Some of the methods we used involved buying 3D cameras, planning out locations in advance, and using Unity to build everything. We found that such a project undertaking is much harder than one would think, and requires a significant amount of work, research, and time, just for one location. In the end, we will continue to improve upon our idea to bring it to everyone everywhere.

Poster #62

Somatic and reproductive age change the expression and distribution of GLD-2 and GLDR-2 in the C. elegans germline

Authors: Kavya R. Rajavel

Summer Program: Spencer Fellowship

Department: Biology and Biotechnology

Advisor(s): Ph.D, Karl-Frédéric Vieux

Abstract:

The reproductive system of C.elegans, as in humans, deteriorates with age, leading to a decline in oocyte quality and reproductive rate. Transcriptomic changes occur in many age-related conditions, including fertility decline. Regulation of RNA is critical to oocyte quality and function; understanding changes in RNA biology in the context of aging is key to understanding its role in age-associated sterility. While other RNA modifications are associated with aging, it remains unclear how RNA tails change in this context. Terminal nucleotidyl transferases, GLD-2 and GLDR-2, mediate the post-transcriptional addition of nucleotide tails at the 3'-ends of RNA to control RNA translation and stability, and both contribute to fertility in C. elegans. They also accumulate in different ribonucleoprotein (RNP) granules, critical condensates for RNA processing. Here, we test the effects of both somatic and reproductive age on the expression and localization of GFP-tagged alleles of GLD-2 and GLDR-2. Through confocal imaging, we quantified the associated GFP signals in the germline of young adults and old sperm-depleted hermaphrodite C. elegans. Quantification of the GLD-2 signal shows no change in overall expression in the germline, but it extends distally as the worms age. In 20% of the aged germlines, we also observed an increase in the number and size of GLD-2 granules. This mirrors the expression of GLD-2 target, GLD-1, which also expands distally in older germlines. However, mating with males limits the distal extension of the GLD-2 signal and prevents the increase in the number and size of GLD-2 granules. Quantification of GLDR-2 signal decreases in nuclei from the distal to proximal

end (germ-cells to oocytes). This decrease is prevented in the pachytene and diplotene regions with age. However, mating with males rescues the decrease in the pachytene and diplotene regions and accelerates it in the oocytes. Future work will resolve how changes in GLD-2 and GLDR-2 distribution impact other transcripts and contribute to age-associated declines in fertility.

Poster #63

RevDecode for Ghidra: Context-Aware Function Matching in an Open Framework

Authors: Daniel Reynolds

Summer Program: STAR Fellowship: Summer Training in Arts & Sciences Research

Department: Computer Science / Cybersecurity

Advisor(s): Professor Robert J. Walls

Abstract:

Binary reverse engineering is a critical task in the field of security, which has many types of tools and approaches associated with it. RevDecode is one such tool which allows for function matching based on relevance, rather than purelysimilarity. In this work, we apply the approach of RevDecode and apply it to a Ghidra plugin, which allow for features and improvements beyond the initial RevDecode project.

RevDecode Ghidra facilitates performance improvements compared to the original RevDecode due to Ghidra API features the code has access to, in running as a Ghidra plugin. Furthermore, the plugin platform allows for the effective and continued performance testing of the algorithms and approaches used, not only in pure performance tests, but also in realistic reverse-engineering environments, therefore allowing us to evaluate the limitations and scalability of our work.

Furthermore, RevDecode Ghidra implements features that integrate into the reverse-engineering workflow, notably the ability for the user to view function matches based on the currently selected function in Ghidra's symbol tree. This allows the user to jump directly to that function's match by clicking on the function's name via the matcher window, which opens the binary containing the matched function, allowing the user to switch easily between the unknown and the matched function. Additionally, in supporting the plugin's use in a realistic reverse engineering environment, the plugin has the ability to match binary solutions to binaries in the corpus, and view these solutions in the plugin, which benefits a realistic use case, a reverse-engineering capture the flag challenge.

Poster #64

Synthesis and Optimization of XanthoneDiAcidPyridinedeCage

Authors: Alexandra Cupit

Summer Program: LaPre Fellowship

Department: Chemistry and Biochemistry

Advisor(s): Shawn C. Burdette

Abstract:

The metal ion Zn2+ has many uses in the body such as a neurotransmitter. Zinc homeostasis is important to continued bodily functioning. A correlation between reduced amounts of zinc and neurodegenerative diseases has been established. A photocage is a molecule that surrounds a bioactive molecule, rendering it inactive until it is released by the photocage uncaging due to the irradiation of light. Zinc Photocage complexes provide the spatial and temporal controlled release of Zn2+ to interrogate cellular signaling. The deCage series of photocages uncages through a process called photodecarboxylation. The synthesis and analysis of DiAcidPyridine (DAP) deCage has the goal of studying free zinc in neuronal cells. Compared to other deCages, preliminary research shows the DAPdeCage has a higher selectivity for zinc over other biological metal ions compared to its predecessor NTAdeCage. While it has similar binding affinity and Zinc selectivity to the DPAdeCage (DPA: DiPicolylAmine), DAPdeCage Zn2+ complex is charge neutral. DPAdeCage and NTAdeCage (NTA: NitriloTriAcetate) are both charged complexes. Charged ions cannot go through cell membranes, so DAPdeCage being neutral charged means that the complex itself is cell permeable. This research aims to optimize the synthesis of DAPdeCage and collect photophysical data.

Poster #65

Investigating The Roles of KhpA & KhpB in Stress Tolerance in M. smegmatis

Authors: Victoria Turner

Summer Program: LaPre Fellowship

Department: Biology and Biotechnology

Advisor(s): Scarlet Shell

Abstract:

Understanding bacterial stress adaptation is critical in addressing persistent infections like tuberculosis. RNA-binding proteins (RBPs) help bacteria survive stressful environments by controlling how genes are turned on or off (1). In Mycobacterium species RBPs are especially important during stress from things like low nutrients, antibiotics, or oxidative damage, helping the bacteria adapt by supporting stress-related gene expression (1). RNA-binding proteins such as KhpA and KhpB are regulators of post-transcriptional gene expression, but their functions in mycobacteria remain poorly defined. This project aims to idenifity how

KhpA and KhpB contribute to stress tolerance and gene expression in Mycobacterium smegmatis, a nonpathogenic model for M. tuberculosis.

We hypothesize that KhpA and KhpB regulate RNA stability and gene expression under stress. Prior work in the Shell lab shows that khpA deletion impairs growth, and Co-IP data suggest both proteins interact with RNase E and with each other (2,3). Together, KhpA and KhpB may influence RNA turnover or compete with ribosomes for regulatory control.

To test this, I am assessing stress tolerance in wild-type, khpA and khpB knockout, and complemented strains of M. Smegmatis under oxidative, nitrosative, and nutrient stress. These findings will clarify mechanisms of RNA regulation in mycobacteria and may highlight new targets for improving tuberculosis treatment.

Poster #66

SAVeD: Semantically Aware Version Discovery

Authors: Artem Frenk

Summer Program: STAR Fellowship: Summer Training in Arts & Sciences Research

Department: Data Science

Advisor(s): Roee Shraga

Abstract:

Our work introduces SAVeD (Semantically Aware Version Detection), a contrastive learning-based framework for identifying versions of structured datasets without relying on metadata, labels, or integration-based assumptions. SAVeD addresses a common challenge in data science of repeated labor due to a difficulty of similar work or transformations on datasets.
SAVeD employs a modified SimCLR pipeline, generating augmented table views through random transformations (e.g., row deletion, encoding perturbations). These views are embedded via a custom transformer encoder and contrasted in latent space to optimize semantic similarity. Our model learns to minimize distances between augmented views of the same dataset and maximize those between unrelated tables. We evaluate performance using validation accuracy and separation, defined respectively as the proportion of correctly classified version/non-version pairs on a hold-out set, and the difference between average similarities of versioned and non-versioned tables (defined by a benchmark, and not provided to the model).
Our experiments span five canonical datasets from the Semantic Versioning in Databases Benchmark, and demonstrate substantial gains post-training. SAVeD achieves highly performant accuracy on completely unseen tables in preliminary testing, and a significant boost in separation scores over its untrained counterpart, confirming its capability to distinguish semantically altered versions. Compared to its untrained baseline, and adapted implementations of prior state-of-the-art dataset-discovery methods like STARMIE, our custom encoder achieves competitive or superior results. Future work will involve hyperparameter

tuning, deeper comparison to State of the Art Dataset Discovery methods (the closest task to this we can find) like Starmie and DiscoverGPT, and ablation studies.

Poster #67

Overexpression of Three Putative Methyltransferase Enzymes in SynBio Chassis Organism P. putida

Authors: Benjamin K. Feldman, Anna M. Kessler

Summer Program: Farny/CAREER student

Department: Biology and Biotechnology

Advisor(s): Dr. Natalie Farny

Abstract:

Pseudomonas putida is a ubiquitous soil bacterium that, owing to its array of metabolic abilities and ability to tolerate environmental stress, is used in synthetic biology to remediate environmental contaminants, a process which entails the design, construction, and employment of genetic circuits. Current methods of achieving such outcomes have been hindered by a lack of knowledge of the modes of gene regulation in P. putida; in particular, epigenetic regulation by DNA methylation has yet to be characterized in the species. Past findings resulted in the identification of seven orphan methyltransferases that could potentially play a role in epigenetic regulation. Vectors containing three of these MTase genes, regulated by the V2TcR promoter, were constructed using PCR amplification and T4 ligation and cloned in NEB 5α E. coli. The genes were then transformed into P. putida AG4775 cells and genome-integrated using a BxB1 recombinase system. Expression of the MTases was assayed via Western blot, while genome methylation levels were determined using 6-methyladenine and 5-methylcytosine enzyme-linked immunosorbent assays (ELISAs). Growth curves were also generated. Methylation levels exhibited only minor differences between MTases, and growth curves were highly similar, possibly due to lower-than-expected levels of MTase expression.

Poster #68

CBTO Photocatalysis: Soluble Lead Removal from Water

Authors: Koby Farrington (Mentor), Joseph Bernard

Summer Program: Undergraduate Research Assistant

Department: Biochemistry

Advisor(s): Dr. Pratap Rao Ph.D.

Abstract:

CBTO is a semiconductor photocatalyst with a band gap of 1.9-2.0 eV, as such, it is able to absorb visible light to perform photocatalytic reactions. An investigation was performed to analyze its ability to perform the reduction of soluble lead ions in a solution of acidic pH. Testing was done with lead nitrate as the lead source and a 300 W Xe lamp as the light source.

Poster #69

Digital Twin for Intelligent Data Analysis

Authors: Varun Bhat, Mohit Patel

Summer Program: Global Lab's Global AI + XR Project

Department: Department of Integrative & Global Studies (DIGS)

Advisor(s): Stephen McCauley

Abstract:

The Global Lab worked this summer to research the creation of VR digital twins using Worcester as the study model. Our technology enhanced global learning initiative, 'Global AI + XR,' aims to engage generative AI and other digital media technologies to transform learning, work, and global collaboration. The goal of this work is to create powerful tools that can visualize future scenarios. For example, our research project in 2024 examined urban heat islands and heat vulnerabilities in Worcester and revealed significant differences between neighborhoods. The digital twin tool allows for immersive experiences that can increase awareness of these complex urban climate change dynamics and facilitate planning around these issues. We worked with the commercial mapping software ArcGIS and researched how to bring parcel level building data into VR environments using the Unity game engine. In doing so, we ran into challenges related to the realistic geo-positioning of Worcester's infrastructure, which we were successfully able to bridge using advanced vector mathematics. Our future work is going to involve adding features like terrain (roads, green spaces, building material), 360 videos and photos of real locations, and optimized rendering to allow realistic walk-throughs of the city in VR.

Poster #70

Transforming Yeast Cells With Lipid Nanoparticles

Authors: Paris Bazemore, Adelyn Fisher, Zekun Li, Scarlett Xu

Summer Program: REU: Integrated Bioengineering Research

Department: Chemical Engineering

Advisor(s): Christina M. Bailey-Hytholt, Eric M. Young

Abstract:

Yeast is essential for the fermented products industry. However, the most common methods used to transform yeast, electroporation, and heat shock, require trial and error that often takes weeks to troubleshoot if not done correctly. A negative result is unclear if DNA did not enter the cell or if DNA entered the cell and did not express, which makes achieving a successful transformation challenging. Additionally, lipid nanoparticles (LNPs) are a delivery method for nucleic acids, including OnPattro, an LNP loaded with interfering RNA (siRNA) for nerve damage treatment. LNPs have successfully delivered nucleic acids to mammalian cells, but few studies have been performed in other organisms such as yeast. In mammalian cells, LNPs enter cells through the formation of vesicles during endocytosis and enter the cell cytoplasm through a process known as endosomal escape. Yeast have been observed to complete endocytosis and endosomal escape, leading to the potential application of LNPs for yeast transformations. LNPs were used to deliver nucleic acids to S. Cerevisiae to streamline the transformation process. LNPs containing green fluorescence protein (GFP) mRNA and GFP plasmid were used to transform S. Cerevisiae, and flow cytometry was used to detect fluorescence. Cells that were mixed with GFP mRNA LNPs and GFP plasmid LNPs showed minimal yet present fluorescence, indicating successfully transformed yeast with LNPs. Moreover, when yeast cells were mixed with GFP plasmid LNPs a fluorescence peak was detected to the right of the control group indicating successfully transformed yeast. Empty LNPs had a size of 144.4 ± 32.09 nm and zeta of -1.99 ± 9.76 mV. The size of mRNA LNPs and plasmid LNPs are 118 ± 37.31 nm and 188.7 ± 51.49 nm. Also, the zeta of mRNA LNPs and plasmid LNPs are –3.16 ± 6.85.

Poster #71

6G OAIC WIFI : Revolutionizing Modern Speed and Security

Authors: Milad Natanzo, Abdullah Yusuf

Summer Program: EREE: Early Research Experience in E-Term

Department: Electrical and Computer Engineering

Advisor(s): Professor Bo Tang

Abstract:

Modern wireless networks face increasing threats from jamming attacks which jeopardize personal information on people's devices. Current networks simply lack the intelligence and adaptability needed to detect and defend against cyber attacks in real time.

In our lab, we emulated an AI-enabled 6G WIFI network designed to actively detect and defend against jamming attacks. When the network detects a jamming signal on the same operating frequency as it, the system automatically switches to a new frequency band in real time avoiding the attack. This new network

presents not only an upgrade in cybersecurity but also greater network performance in terms of speed and data handling capability.

The potential applications of this technology are endless. Beyond consumer privacy and commercial use, the network shows great promise in military and national security where secure communications and networks are critical

This research was made possible through the sponsorship of WPI's EREE program and conducted under the mentorship of Milad Natanzo and Professor Bo Tang at the Computational Intelligence and Learning Systems (CILS) Lab. We also acknowledge Open AI Cellular, whose open-source 5G software and architectural framework were foundational to the development of our emulation system.

Our research demonstrates that AI 6G networks can provide a more secure and resilient foundation for future wireless communications, addressing both current flaws and emerging global challenges.

Poster #72

Antimicrobial Bioresorbable Vascular Grafts

Authors: Alexis Estime

Summer Program: EREE: Early Research Experience in E-Term

Department: Biology/Biotechnology

Advisor(s): Professor Yonghui Ding (PhD, Rao Fu (PhD, Ni Chen (Post-Doc, BME)

Abstract:

Cardiovascular diseases such as atherosclerosis, the build up of plaque inside artery walls, can lead to peripheral artery disease (PAD), which affects over 15.5 million individuals over the age of 20 in the United States. These conditions are often treated through surgical interventions of synthetic vascular grafts (SVG): to restore blood flow by rerouting the blocked or damaged arteries. However, the current grafts face many limitations including, non-biodegradability and fatal infection related complications ultimately leading to poor long-term patency. Vascular Graft infection (VGI) remains the most prominent challenge to combat with SVGs with a mortality rate of 40% and a reinfection rate of 18% [2]. \

To address these challenges, our research aims to develop a bioresorbable, anti-infective vascular graft using two photocurable citrate-based polymers: mPDC and mPOC. These materials were synthesized with various concentrations of MAES and then processed into ink disks. The disks were designed to increase carboxyl (-COOH) content, as confirmed by FTIR, allowing for conjugation with KR-12 which is an antimicrobial peptide intended to reduce infection risk. Mechanical tests using the CellScale system confirmed that the polymer inks exhibit appropriate tensile strength for vascular use and tensile strength tests. Biodegradation testing ensures that the graft material safely breaks down in the body, enabling cell infiltration and tissue

regeneration, which allows the patient's own tissue to replace the graft and improve long-term patency. Based on the initial results, these biomaterials show promising potential in antimicrobial SVG technology.

Poster #73

pH-responsive, vancomycin-loaded liposomes for treatment of Staphylococcus epidermidis

Authors: Alexandra Harrison, Emily Lei, Patryck Michalik, Sydney Packard, Scarlett Xu, Winnie Yang

Summer Program: EREE: Early Research Experience in E-Term

Department: Chemical Engineering

Advisor(s): Christina M. Bailey-Hytholt, Elizabeth J. Stewart

Abstract:

Staphylococcus epidermidis is one of the most common causes of hospital-acquired infections due to biofilm formation on medical device surfaces. Biofilms are communities of bacteria encapsulated in self-produced extracellular polymeric substances and have reduced susceptibility to antibiotics. Biofilms develop pH gradients within their structures during biofilm development. Liposomes are nanoparticles used in drug delivery and can be engineered to be pH responsive. Here, we formulated pH-responsive liposomes for targeted delivery to S. epidermidis biofilms. Liposomes were formulated by thin-film hydration followed by extrusion. We tested eight different compositions. Key components of the liposomes were MC3, an ionizable lipid, a helper lipid (1,2-dioleoyl-sn-glycero-3-phosphocholine (DOPC) or 1,2-distearoyl-sn-glycero-3-phosphocholine (DSPC)), and cholesterol. A promising liposome formulation was identified through varying mole percentages of MC3 and helper lipids. Liposomes were added to pH buffers ranging from 3.5 to 8 to evaluate the effect of pH on liposome size and zeta potential. Liposomes comprised of 65 mol% MC3, 25 mol% DSPC, and 10 mol% cholesterol were found to be 151.7nm with a zeta potential of -10.8mV at pH 7.5. There was a notable size increase that correlated with decreasing pH, especially at pH 5.5, where the size increased to 292.7 nm. The zeta potential was neutral at pH 5.5 and positive at pH 5. The increase in liposome size and zeta potential with decreasing pH indicates that the formulation is promising for pH-responsive payload release in biofilms. Increasing the concentration of MC3, from 50 mol% to 65 mol%, resulted in a decrease in the zeta potential of neutral liposomes, aiding in protonation at a higher pH. When comparing the two helper lipids, liposomes formed with DSPC protonated within the pH range of biofilms. Through changing the concentrations of different lipids, liposomes can be formulated to protonate at pH values within the range of S. epidermidis biofilms.

Poster #74

Knockout of indiscriminate terminal-nucleotidyl transferase, GLDR-2, compromises male fertility in C. elegans

Authors: Danni Li, Shuling Lin, Brian Riley

Summer Program: EREE: Early Research Experience in E-Term

Department: Biology & Biotechnology

Advisor(s): Karl-Frédéric Vieux

Abstract:

GLDR-2 is a terminal nucleotidyl transferase in Caenorhabditis elegans that adds mono-A tails to microRNA precursors, and poly-A, poly-U, or mixed tails to other coding and non-coding RNAs. It is robustly expressed in the hermaphrodite germline, making it a gene of interest for reproductive biology. While prior research has shown that the absence of GLDR-2 does not affect hermaphrodite fertility, it may play a role in the fertility of male worms. Qualitative observations suggest that the absence of GLDR-2 in male nematodes may impact fertility due to difficulty in generating and maintaining a population of gldr-2 null males. To characterize GLDR-2 expression in male worms, GFP-tagged GLDR-2 male nematodes were generated using two methods. The first method involved crossing wild-type males with GFP-tagged hermaphrodites, while the second consisted of heat shocking GFP-tagged hermaphrodites to disrupt meiosis and generate the XO male genotype. GFP-tagged GLDR-2 males were imaged using confocal microscopy, revealing nuclear expression of GLDR-2 throughout the male germline. GLDR-2 expression decreases after pachytene and is absent during the later stages of meiosis and spermiogenesis. Additional imaging with DAPI or mCherry staining will be used to visualize germline nuclei to identify specifically which stages GLDR-2 is present in. The offspring produced by gldr-2 null males were quantified through 5-day brood counts. Crosses between gldr-2 null males and wild-type hermaphrodites resulted in fewer offspring when compared to brood counts from wild-type males and wild-type hermaphrodites. On average, the crosses with gldr-2 null males decrease about 33% in comparison to crosses with wild-type males. Future brood counts using feminized hermaphrodites that lack sperm will further validate GLDR-2's role in male fertility.

Poster #75

Causal Inference with LLM Agents

Authors: Aaron Belikoff, Matthew Lamborne

Summer Program: REU: Applied Artificial Intelligence for Advanced Applications

Department: Data Science

Advisor(s): Raha Moraffah

Abstract:

Causal inference is the process of determining the effect of one variable on another by estimating what would happen under different hypothetical interventions. It is a problem that requires both quantitative reasoning skills and common-sense causal knowledge of the world. Previous methods have attempted to utilize LLMs for causal inference, relying on their world knowledge and reasoning ability. However, it is hard for LLMs to bridge the gap between causal knowledge from the semantic information in a dataset and practical causal inference. In this paper, we propose an end-to-end approach that aims to allow LLM agents to conduct causal inference without manual annotations regarding causal structure or method. We propose a 6-step reasoning framework that encourages the model to do causal inference end-to-end. The framework operates in identification, planning, and tool calling phases, for which we integrate tools from existing causal reasoning libraries. We evaluate our framework using Qwen3-14B on QRData, a benchmark covering both numerical causal inference and multiple-choice causal discovery tasks. We also introduce a modified version of the benchmark without explicit instructions about method use or variable roles to assess end-to-end capability. In general, we show that our framework is stronger, outperforming the baseline set by GPT-4 with ReAct tool calling despite using a smaller model. In particular, it is better at causal inference with limited guiding information. These findings highlight the value of structured causal reasoning frameworks in underspecified settings.

Poster #76

Large Language Model Inference of Macromolecular Complex Composition via Consensus and Experimental Data Integration

Authors: Yue Bao, Vasily Gorbunov, Dmitry Korkin, Daniel Lynch, Mikhail Zhernevskii

Summer Program: Bioinformatics and Computational Biology

Department: Bioinformatics and Computational Biology

Advisor(s): Dmitry Korkin

Abstract:

Large language models (LLMs) have recently joined the cohort of advanced AI approaches in paving new, transformative ways of acquiring data across diverse knowledge domains. However, their capacity to retrieve the in-depth, domain-specific information useful to scientists and researchers remains uncertain. One such gap in modern cellular biology lies in identifying major macromolecular complexes—conserved biological units essential to many cellular processes. Cataloging large complexes, such as the ribosome or RNA polymerase, along with their constituent genes, presents a major challenge for LLMs due to current limitations, such as the tendency to produce hallucinations. In this study, we evaluate the ability of six state-of-the-art LLMs to retrieve data on 91 protein complexes and their components by integrating LLM outputs with experimental multi-omics data. We achieved 84.5% accuracy on the consensus of LLM outputs integrated with experimental data, compared to 76.4% accuracy of the best unintegrated single LLM result,

produced by ChatGPT. We conclude that LLMs hold significant promise for enhancing the efficiency of large-scale retrieval of specialized biological data.

Poster #77

Design Optimization in Legged Robots Using Reinforcement Learning

Authors: Xavier Horta, none

Summer Program: EREE: Early Research Experience in E-Term

Department: Robotics engineering and mechanical engineering

Advisor(s): Mahdi Agheli

Abstract:

Throughout the research program, I explored how to create optimized designs of robots for specific desired tasks, which is normally a time-intensive and expensive process. Recent methods in modern-day Reinforcement learning, such as deep reinforcement learning (DRL) have offered a promising alternative. This has allowed policies to be trained to which allows them to learn optimization of both morphology and control without prior knowledge. Through this project, I have explored multiple RL methods that optimize robot design. Through the selected method of having agents learn through trial-and-error within simulated environments. Methods such as standard DRL, morphology learning, and multi-task RL are compared in terms of their effectiveness in generating high-performance designs. DRL allows robots to discover non-greedy actions with higher reward potential, reducing the need for iterative redesigns. Using DRL and applying free-evolution algorithms often yields an optimized performance; however, even the constrained algorithms demonstrate the capacity to find an optimal solution. While morphology learning enables agents to adapt their structure during training, making difficult tasks more tractable with fewer computational resources. Throughout this research, the recommended method for completing simpler tasks is DRL, while more complex scenarios may benefit from morphology evolutionary algorithms. Future work involves implementing these methods in a double pendulum environment to validate the effectiveness of learned designs in achieving target-oriented movement efficiently. This study highlights the potential of reinforcement learning to revolutionize robotic design by reducing development costs and unlocking novel configurations beyond traditional engineering intuition.

Poster #78

LLMs Meet Time Series Models: Harnessing Internal Knowledge for Few-Shot Forecast of Migration Flows

Authors: Phong Cao, Jacob Molnia, Shannon Song, Elizabeth Stanish

Summer Program: REU: Applied Artificial Intelligence for Advanced Applications

Department: Data Science

Advisor(s): Fabricio Murai

Abstract:

Global forced migration has reached unprecedented levels, with approximately 123.2 million forcibly displaced individuals recorded at the end of 2024. Accurate forecasts of migration flows are essential to allocate the resources that migrants need for a timely and effective humanitarian response. Recent machine learning and deep learning techniques have been proposed to predict migration flows from factors influencing them. However, forecasting migration flow remains a major challenge due to the sparsity and relatively short history of migration-related data, two problems with which current methods struggle. As a result, current methods rely on exogenous variable selection based on either prior research or data-driven approaches that similarly do not have enough statistical signals in scenarios with limited historical observations. To address these limitations, we propose a novel methodology that leverages the internal knowledge of large language models (LLMs) to guide the selection of relevant exogenous variables. Specifically, we task LLMs with choosing contextually appropriate features from a provided candidate list, which are then fed into time series forecasting models--such as SARIMAX or time series foundational models. We evaluate our approach using FRONTEX data on migration into the European Union from 2009 to 2024. Experimental results demonstrate that LLM-guided feature selection consistently improves forecast accuracy over models using the full feature set. Moreover, when paired with the appropriate time series model and the optimal number of features, the LLM-based method outperforms traditional data-driven selection techniques. These findings highlight the potential of LLMs to select meaningful variables related to migration forecasting from contextual prompts alone and improve migration forecasting in data-scarce environments.

Poster #79

LLMs Meet Time Series Models: Harnessing Internal Knowledge for Few-Shot Forecast of Migration Flows

Authors: Phong Cao, Jacob Molnia, Elizabeth Stanish

Summer Program: STAR Fellowship: Summer Training in Arts & Sciences Research

Department: Computer Science

Advisor(s): Fabricio Murai, Shannon Song

Abstract:

Global forced migration has reached unprecedented levels, with approximately 123.2 million forcibly displaced individuals recorded at the end of 2024. Accurately forecasting migration flows is essential to

allocate resources migrants need for timely and effective humanitarian response. Recent machine learning and deep learning techniques have been proposed to predict migration flows from factors influencing them. However, forecasting migration data remains a major challenge due to the sparsity and short history of migration-related data. Current methods rely on exogenous variables selection based on prior research, or data-driven approaches that do not have enough statistical signals in scenarios with limited historical observations. To address these limitations, we propose a novel methodology that leverages the internal knowledge of large language models (LLMs) to guide the selection of relevant exogenous variables for migration forecasting. Specifically, we prompt LLMs to choose contextually appropriate features from a candidate list for a given migration route, which are then fed into time series forecasting models - such as SARIMAX or time series foundational models. We evaluate our approach using FRONTEX data on migration into the European Union from 2009 to 2024. Experimental results demonstrate that LLM-guided feature selection consistently improves forecasting accuracy over models using the full feature set. Moreover, when paired with the appropriate time series model and the optimal number of features, the LLM-based method outperforms traditional data-driven selection techniques. These findings highlight the potential of LLMs to select meaningful variables related to migration forecasting from contextual prompts alone and improve migration forecasting in data-scarce environments.

Poster #80

Synthesis of Hydrophobic Dendrimers to Prevent MOF-5 Hydrolysis & Degradation

Authors: Samuel Olson, Ronald Premo

Summer Program: Physics REU

Department: Chemistry/Biochemistry

Advisor(s): Shawn Burdette, Ronald Grimm

Abstract:

Macromolecule and nanocontainers remain compelling candidates for the on-demand delivery of therapeutic drugs. One such candidate is MOF-5, a metal organic framework we formed by the coordination of zinc metal centers (using zinc nitrate hexahydrate) and terephthalic acid through a solvothermal crystal growth in N,N-diethylformamide. We recently demonstrated that capping of MOF–5 with triphenylacetate groups blocks the release of guest molecules as determined by UV-Vis of guest diffusion into the surrounding medium. We further extended this capping methodology to include a photocleavable nitrophenyl group that yielded on-demand release of guest molecules upon UV illumination. Herein, we extend the molecular capping toolbox to include oligomer and dendrimer moieties that have the potential for chemical tunability, biocompatibility, and further modes of guest release. Given that MOF-5 is vulnerable to hydrolyzing when encountering water, we explored the synthesis of a dendrimer that is hydrophobic to attempt to protect from degradation given the intended application as a nanoparticle. Dendrimer chemistry focused on coupling benzyl bromides at phenol groups. We explored growing dendrimers from a MOF-surface-attached 3,5-dihydroxybenzoic acid, as well as growing dendrimers in solution from 3,5-dihydroxy(methyl)benzoate followed by acid deprotection and attachment to establish whether attach-then-grow or grow-then-attach yields the best

results. X-ray diffraction was used to verify successful MOF syntheses. Infra-red spectroscopy and nuclear magnetic resonance qualified dendrimer synthesis methodology. X-ray photoelectron spectroscopy established successful dendrimer attachment. We present the results in the context for future dendrimer-based capping of MOFs as nanocontainers for therapeutic drug delivery.

Poster #81

Immigration Policy Analysis with Generative AI: Creating Accessibility Through Storytelling and Video Format

Authors: Jim A. Murcia Calderon, none

Summer Program: EREE: Early Research Experience in E-Term

Department: Computer Science

Advisor(s): Crystal Brown, Oleg Pavlov

Abstract:

Policymaking is an important aspect of any nation involving many interconnected variables, which often leads to a slow policymaking process. Modeling how policy works can present even more barriers for researchers. However, artificial intelligence (AI) might help us model policy changes. A team of interdisciplinary undergraduate students, working on their senior thesis at WPI under the leadership of four faculty advisors, trained an AI model to track and model the effects of immigration policy. Their findings showed potential for using AI to model policy performance, but more importantly, that the project was ready to be taken further. It only needed higher visibility and higher public engagement. To help showcase and spread awareness of the trained model, the information was presented in a short video abstract format. The video presented the original work with graphics and engaging photos that make the original project more palpable to the public. More importantly, it condensed all the key information of the project into under 6 minutes without losing any important meaning. The video format allowed for increased accessibility and engagement, offering a starting point for further discussion, improvements, and implementation in hopes of making the research more engaging and understandable for a broader audience.

Poster #82

Developing a Mild Blast Traumatic Brain Injury Model in C. elegans

Authors: Fox Avery, Jyothi Rao

Summer Program: REU: Integrated Bioengineering Research

Department: Biomedical Engineering

Advisor(s): Dirk Albrecht

Abstract:

Traumatic brain injury (TBI) is a pressing global public health concern. In the United States alone, 1.7 million people suffer from TBI annually. As global conflict increases, so does exposure to harmful blast waves and blast-induced TBI (bTBI). Civilians in conflict zones and service members alike are at risk of bTBI. Mild bTBI also may be underreported or overlooked as tissue damage is not typically visible, and there is no notable event of blunt force trauma to the head. Unlike blunt force brain injuries, blast waves propagate through the skull, tissue, and vasculature. As such, the mechanism, pathology, and outcomes of bTBI are poorly understood, and there is no bTBI-specific treatment. Current bTBI models cannot access real-time functional changes associated with bTBI. Acute behavioral symptomology is crucial information for diagnostic criteria. This research presents a Caenorhabditis elegans model for studying bTBI. Compared to current in vivo mammal models, C. elegans have a well-mapped and simple nervous system, they are semi-translucent, allowing for live imaging during blasts, and have few ethical concerns. We developed a fluid percussive system that propagates blast overpressure through C. elegans housed in a syringe for high-throughput behavioral assays or a blast chamber on a microscope slide for imaging. This system produces consistent blast waves with peak pressures of 65 psi. Following exposure to 10x 30 psi blasts, C. elegans demonstrated acute mechanosensory and motor deficits, which could recover within 2 hours. Imaging of the AWA chemosensory neuron revealed a stark decrease in activity immediately after blasts, followed by a period of recovery reflective of the observed mechanosensory and motor deficits and recovery. Recovery potential after more severe bTBI has yet to be measured. This method enables further research to uncover how sensory and motor functions are temporarily diminished.

Poster #83

Experimental Measurement of Plant Cell Wall Mechanics in Tip Growing Model Physcomitrium Patens

Authors: Lucas Ramondo, Rholee Xu

Summer Program: Manning/Lesser Fellowship

Department: Bioinformatics and Computational Biology

Advisor(s): Luis Vidali, Min Wu

Abstract:

The cell wall is rising in significance with its relation to biomass, renewable energy, and materials because of its ability to continuously rearrange and extend against the high internal turgor pressure. Previous research has revealed an elastic gradient in the cell wall, prompting further investigation into the nature of this property. Our project examined tip-growing cells, utilizing the moss model organism Physcomitrium patens to study and confirm the elastic gradient. Tip growth is characterized by polarized growth, a process in which the cell elongates in a self-similar manner, serving as a simpler model due to its symmetric nature. Our experiments utilized marker point tracking, reliant on imaging the cell wall outline and fluorescent bead

tracking. The preliminary results showed a difference in the shrinkage of the two cell types of P. patens, the caulonema and chloronema, with the former shrinking more. This shrinkage equates to larger elastic strains at the side of the cell. In combination with marker point tracking, a future model is being developed to measure the cell wall elasticity in P. patens. As a complement to our study, we also aimed to confirm one of the key proteins involved in cell wall properties, playing a critical role in wall rearrangement. In essence, expansins utilize microfibril sliding, which loosens the cell wall; however, it has been shown that they require a low pH environment for activation. We hypothesized an acidic environment at the tip as more expansins are mandatory in the growth stage. Thus, our research examined the pH difference from the edges to the tip of the cell wall by exposing the cell to two different wall dyes. From this comparison, a ratiometric calculation will be made to determine the exact pH value of the cell wall.

Poster #84

Developing Quantum Circuit Compilation Strategies for Hybrid Light-Matter Blind Quantum Computing Architecture

Authors: Gefen Baranes, Johannes Borregaard, Nik O. Gjonbalaj, Sunny Kang, Francisco Machado, Iria W. Wang

Summer Program: STAR Fellowship: Summer Training in Arts & Sciences Research

Department: Physics

Advisor(s): Raisa Trubko, Susanne F. Yelin

Abstract:

As we approach the realization of scalable quantum computers, it is increasingly important to ensure that clients with limited quantum resources have secure access to such devices. Blind quantum computing (BQC) protocols offer a compelling solution by enabling clients to delegate quantum computations to powerful servers without revealing their data. A newly developed fault-tolerant BQC architecture—the hybrid light-matter approach [Science 388, 509-513 (2025), arXiv:2505.21621]—uses photonic client-server communication to implement blind gates. This approach also allows select gates to be implemented directly by the server (non-blindly), which significantly reduces the costly photonic overhead but at the expense of revealing some client information. Compiling partially blind quantum circuits that efficiently obscure specific aspects of the client's computation remains a key challenge. This motivates the search for design strategies for partially blind circuits that balance security and resource efficiency. In this work, we develop a new circuit algebra for this partial-blindness model and specifically explore its application in Hamiltonian simulation algorithms to demonstrate a practical approach.

Poster #85

Analytical Solutions to the Hypersonic Re-entry Problem

Authors: Ameer Al-Behadili, Oleksii Padun

Summer Program: EREE: Early Research Experience in E-Term

Department: Aerospace Engineering

Advisor(s): Ye Lu

Abstract:

Trajectory prediction is critical to the success of planetary missions, especially during atmospheric entry where rapid deceleration and high dynamic pressures occur. This research investigates the Mars Science Laboratory (MSL) Curiosity rover's entry trajectory using three distinct approaches: real mission data obtained from NASA's SPICE system, an analytical solution based on simplified flight dynamics, and a numerical solution using MATLAB's ODE solver. The analytical model, derived under assumptions such as constant gravity and exponential atmosphere, offers a fast, low-cost estimation of trajectory behavior during the early entry phase. The numerical solution, while more computationally intensive, integrates the full nonlinear equations of motion to provide higher accuracy. Both models were validated against SPICE-derived flight data to assess performance across varying altitudes. Results show that the analytical solution performs well at higher altitudes but diverges as the spacecraft descends deeper into the atmosphere. This highlights the trade-off between model simplicity and accuracy and reinforces the role of analytical models as effective tools in early mission design.

Poster #86

Chemokine Functionalized Leaf-Derived Vascular Scaffolds (LeaVS) Support Endothelial Recruitment

Authors: Leah Braun, Glenn R. Gaudette, George D. Pins, Bryanna L. Samolyk, Antonio C. F. dos Santos, Catherine F. Whittington

Summer Program: REU: Integrated Bioengineering Research

Department: Biomedical Engineering

Advisor(s): George D. Pins

Abstract:

More than 6.5 million Americans suffer from chronic wounds annually. To restore quality of life and reduce mortality, engineered skin substitutes are often necessary. However, currently available options have insufficient vascular networks, which can lead to graft failure. Previous work has shown that decellularized

spinach leaves (leaf-derived vascular scaffolds, LeaVS) are a promising alternative, as their vascular structures are retained and similar to that of human skin. With the novel contribution of chemokine functionalization, we hypothesize that neovascular network formation in LeaVS can be enhanced. Toward this goal, this work evaluates the adsorption rate, release kinetics, and endothelial recruitment of functionalized LeaVS. Using Transwell migration assays, we found that functionalization with vascular endothelial growth factor A (VEGF-A) or sphingosine-1-phosphate (S1P) results in 2- and 7-fold increases, respectively, in endothelial migration toward LeaVS. This is a vital step in their revascularization and suggests that S1P functionalization is a strong candidate for enhancement.

Poster #87

Flipping the Switch – Does IC2 Regulate Kek5 Activity?

Authors: Taina Marigny

Summer Program: CLIMB@WPI

Department: Biology/Biotechnology

Advisor(s): Joseph Duffy

Abstract:

The transmembrane protein, Kekkon 5 (Kek5) modulates the Bone Morphogenetic Protein (BMP) signaling pathway and remains broadly expressed throughout development in Drosophila melanogaster. Structurally, Kek5 has a disordered intracellular (IC) region containing a set of evolutionarily conserved short linear motifs, SLiMs, of unknown function. One SLiM in Kek5, IC2, is similar to a SLiM, P1, in the Deleted in Colorectal Cancer (DCC) protein. Interestingly, the P1 SLiM appears to regulate DCC activity between two distinct states – driving either axon attraction or repulsion in humans. Similar to DCC, Kek5's activity appears to be dependent upon its SLiMs. Most notably, previous work has shown that the IC2 SLiM is necessary to prevent lethality when Kek5 is misexpressed, as high levels of lethality are observed only with Kek5 variants lacking IC2. One model is that IC2 regulates Kek5's activity between distinct states analogous to DCC. We propose that the IC2 SLiM regulates the activity of Kek5 via the ICs4/5 SLiMs. Without IC2, ICs4/5 are unregulated, triggering the high levels of lethality observed when Kek5ΔIC2 is misexpressed. In this scenario, additional deletions of ICs4/5 may have the potential to suppress the aberrant lethality of Kek5ΔIC2. Therefore, our goal is to determine how the IC2 SLiM regulates Kek5 and assess the structure-function significance of SLiMs. To determine the potential relationship between IC2 and ICs4/5, we created two new Kek5 deletion variants, Kek5Δ245 and Kek5Δ345, using site-directed mutagenesis. In addition, to further characterize the effects of IC2 deletion, we continued prior work on mapping the Kek5ΔIC2 transgenic lines and assessing their function via the GAL4/UAS misexpression system. Finally, we assessed the overall structural significance of Kek5 SLiMs by creating protein predictions of Kek5 SLiM deletion variants. By determining the functional mechanisms of Kek5 SLiMs, we seek to expand the understanding of complex developmental signaling pathways.

Poster #88

Preparing for Bi-Fluorescence Complementation to Validate Protein-Protein Interactions

Authors: Edward Corolla, Micah Dharma

Summer Program: independent summer research (Albrecht lab)

Department: Biology & Biotechnology

Advisor(s): Luis Vidali

Abstract:

As plants undergo polarized cell growth, cargo-carrying vesicles are recruited to fuse into the plasma membrane. The exocyst is an important, large protein complex that contributes to vesicle fusion through tethering. Our preliminary mass spectrometry data from pulldowns and proximity labeling (TurboID) indicate that there are multiple interactors associated with the complex. To validate these, we plan to use bi-fluorescence complementation (Bi-FC), where two components of a fluorescent protein are fused to two proteins that interact with each other. Once the proteins bind, the fluorescent protein will begin functioning. The fluorescent protein mNeonGreen2 (NG2) was used in this study. To test for activity, we need to generate controls for split NG2. We plan to create positive controls for imaging using StreptactinXT and StrepTagII. During this, we will produce a protocol for transformation and an image processing pipeline to monitor transformation efficiency. Finally, we plan to optimize DNA yield for plant transformation through alternative plasmid DNA preps. In this investigation, we determined that NG2 is expressed in P. patens. Increasing concentrations beyond 30 µg did not improve transformation efficiency, but the mean fluorescence of protoplast in 45 µg increased. Preliminary results of the DNA preps produce greater DNA yield than commercial midiprep.

Poster #89

Tolerance of Mammalian Cells and C. elegans to E-60, an Eco-Friendly, Safe, Peracetic Acid Disinfectant

Authors: Fox Avery, Brendan Dodier, Logan Johns, Soven Mehta

Summer Program: independent summer research

Department: Biomedical Engineering

Advisor(s): Dr. Dirk R. Albrecht, Dr. Sakthikumar Ambady

Abstract:

Disinfectants are widely used in healthcare, agriculture, hospitality, and household settings to reduce pathogen transmission. However, popular chemical disinfectants such as bleach and quaternary ammonium compounds can have adverse health effects and environmental impact.
EraDOCate E-60 is a peracetic acid (PAA)-based disinfectant with an EPA label for a 60-second kill time for pathogens like COVID-19, RSV, and influenza, compared with over 10 minutes for other disinfectants. By degrading without residue into CO2 and water, environmental impacts of disposal are minimized. This project aimed to measure viability of mammalian cells and a small model organism (the roundworm Caenorhabditis elegans) to short-term exposure of E-60 disinfectant and to identify the maximum tolerated dose. A neutral pH saline formulation was tested by ATP disinfection assay (Charm Novalum and PocketSwab) and found to reduce contamination equally to standard E-60. To assess mammalian cell viability, NIH3T3 fibroblasts were seeded onto 24-well plates, allowed to adhere for 24h, and exposed to neutral pH PAA concentrations from 0 to 10,000 ppm for 2 mins. By microscopy following staining, viability was determined to be decreased at 1,000 ppm and above, with no effect at 100 ppm or below. To assess the tolerance of organisms to E-60, the nematode C. elegans was exposed to PAA varying concentrations for about 10 min. Animals in 100 ppm or below showed no effect on motility, touch response, or locomotion after 2 hours. At 1,000 ppm, animals showed slight, temporary effects but largely recovered, whereas bleach killed all animals in under 2 min. Together, these results indicate that E-60 disinfectant is less harmful to cells and organisms than bleach, but fast disinfection at full EPA label strength (1135 ppm) can reduce viability. Instead, longer exposures to lower concentrations are recommended for optimal safety and disinfection efficacy.

Poster #90

PMKS+: An Application for Generating and Analysing Planar Linkages

Authors: Randy Gomez, none

Summer Program: EREE: Early Research Experience in E-Term

Department: MME, CS

Advisor(s): Professor David Brown (CS), Professor Pradeep Radhakrishnan (MME)

Abstract:

PMKS+ is a simulation tool in a website designed to analyze the use of mechanical linkages. The software had user interface (UI) inconsistencies as well as some features not functioning as intended. During the EREE (Early Research Experience in E-Term) period, various updates were carried out. Spacing for the user inputs and info were standardized, then applied to the Edit and the Three Position Synthesis panels. This standard has also been documented for future researchers. The colors as well as the designs of the panels were also updated to be more consistent. Undo and redo functionalities were integrated into the 'End Points' and 'Length & Angle' sections of the three-position synthesis tab. Other updates related to various other UI

elements were carried out. These improvements have made PMKS+ much more reliable in performance and appearance.

Poster #91

The pipeline to a running robot

Authors: Sylvia Strayer, none

Summer Program: Farny/CAREER student

Department: Robotics Engineering

Advisor(s): Constantinos Chamzas

Abstract:

The goal of my project was to take an MPC controller simulation and alter it to be used on a real world robot. I was given this project because I wanted to get a taste of working in a lab setting and an introduction to working with industry tools and systems. In order to achieve this goal I started out by learning C++, the basics of ROS, and how to use Docker. Then, I put together my knowledge to alter the launch files of the robot to bypass the simulation elements and use parameters from the robot instead. The result was that I was able to send commands to the robot and the robot would create paths to the destinations I wanted, but unfortunately something with the MPC controller that I was given caused it to return the wrong commands. Overall, my goal was achieved as while the robot did not work correctly, I still learnt a lot about how the software behind robots is put together and I achieved my goal of learning about the systems that power modern robots. My next step would be to troubleshoot the MPC controller to try and get it to work with the robot.

Poster #92

Evaluating the impact of collagen stiffness and inflammatory cytokine exposure on lymphatic capillary junction formation and permeability

Authors: Annabelle K. Feller, Stephen M. Larson

Summer Program: REU: Integrated Bioengineering Research

Department: Biomedical Engineering

Advisor(s): Catherine F. Whittington

Abstract:

Title: Evaluating the impact of collagen stiffness and inflammatory cytokine exposure on lymphatic capillary junction formation and permeability

Authors: Annabelle K. Feller (1,2), Stephen M. Larson (1), Catherine F. Whittington, Ph.D (1)
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Chronic lymphedema is characterized by disrupted lymphatic drainage and fluid retention. Excess tissue deposition and increased tissue stiffening around lymphatic capillaries perpetuate lymphatic dysfunction (e.g., altered cell junctions) and chronic inflammation. Our previous work showed that lymphatic endothelial cell (LEC) junctions changed when grown on type I collagen at stiffness levels comparable to acute (~1 kPa) and chronic (~6 kPa) lymphedema, but these studies were performed without inflammatory signaling that occurs in chronic lymphedema. The current study aims to determine whether expression and localization of VE-Cadherin and ZO-1, two major LEC junction proteins, are affected by matrix stiffness and exposure to TNF-α, an inflammatory molecule. Qualitative analysis revealed that TNF-α treatment produced discontinuous VE-Cadherin expression on soft and stiff matrices but no difference in VE-Cadherin thickness. However, we noted limitations in our thickness quantification method due to fewer overall cell junctions in TNF-α treated samples, suggesting a need for other image analysis techniques. The number of branchpoints (measure of continuity), endpoints, and VE-Cadherin objects per nucleus (measures of discontinuity) were identified as additional quantitative measures of VE-Cadherin junction formation and continuity. Branchpoints decreased with treatment, while endpoints and number of VE-Cadherin objects increased. ZO-1 has a different expression pattern, highlighting unique responses from each junction protein to changes in the mechanical environment and inflammatory stimulation. Radial distribution of positive signal across the cell body was identified as a potential measure of ZO-1 localization, and TNF-α treatment decreased ZO-1 expression at the cell membrane on soft and stiff matrices. Results from this work yielded improved quantitative assessments for LEC junction proteins that will further clarify tissue contributions to capillary function. Future work will utilize a lymphatic capillary-on-a-chip platform to correlate changes in junction formation with fluid movement across capillary walls, allowing us to improve in vitro modeling of lymphatic dysfunction.

References: (1) Kolarzyk, A.M. et al., Cold Spring Harb Perspect. Med., 2022, 12(9):a041169. doi:10.1101/cshperspect.a041169. (2) Ruliffson, B.N.K. et al., Lymphatics, 2024, 2(3):177-194. doi: 10.3390/lymphatics2030015.

Poster #93

Effects of Tensile Strain on Ti3C2Tx Thin FIlms

Authors: Mattan Mohel

Summer Program: STAR Fellowship: Summer Training in Arts & Sciences Research

Department: Physics and Mathematics

Advisor(s): Jeannine Coburn, Kateryna Friedman, Lyubov Titova

Abstract:

MXenes are an emerging class of 2D transition metal carbides and nitrides with promising applications in optoelectronics and biomedical devices. Their high electrical conductivity and biocompatibility position them as strong candidates for next-generation wearable, stretchable electronics. To assess their suitability for such applications, we investigate how the electromagnetic properties of MXene thin films respond to tensile strain in the femtosecond timescale, and explore reproducible methods for analyzing MXene films under these conditions.